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CHEMICAL & METALLURGICAL ENGINEERING

January 4, 1922

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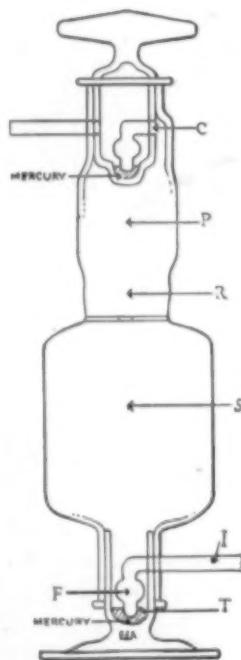
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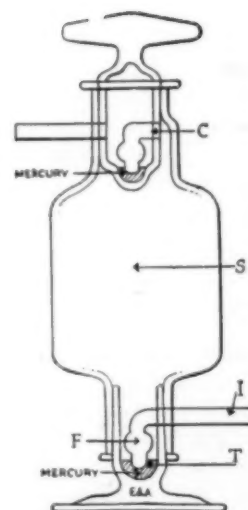
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Volume 26

New York, January 4, 1922

Number 1

Forgetting Those Things Which Are Behind

GLANCING over our editorial salutation of a year ago in which we attempted to portray an optimistic view of the year that has just passed, we are struck with the fact that in many respects the promise has not been performed. Tariff legislation, which was then considered to be of primary importance in the revival of business, still awaits the intelligent attention of Congress. Revenue legislation, which was also a factor in the expected return to normal business conditions, was enacted too late in the year to relieve materially the burden under which business was already staggering. The situation with regard to foreign exchange has not been improved, with its consequent prohibition on international trade. In short, it would seem as though the skyrocket career of 1920 has had its inevitable sequel in the descending stick throughout 1921.

On the other hand, the feeling of optimism and confidence with which we approached 1921 has not been dissipated, although the events which subsequently supported and justified it were not apparent at the beginning. There has been increasing evidence of willingness on the part of business men to accept fundamental economic principles and to ignore artificial panaceas and nostrums in their attempts to revive business. This influence has been felt in Congress and is undoubtedly the principal reason why a high tariff bill has not been passed, as might have been expected under existing political conditions. Economic sanity has prevailed over political expediency.

The tariff is but one item in which there has been evident willingness to take the broad international rather than the narrow national view. The Conference on Limitation of Armament is another. Its success has been such that already there is a demand for a second international conference to solve some of the fundamental economic problems that now vitally affect the business of all nations. Add to this the fact that through Federated American Engineering Societies attention has been forcibly directed to the necessity for eliminating waste in industry, and we have a trio of influences that augur well for the future and serve to relieve the pessimism which otherwise might prevail in a cursory review of 1921.

But we are more concerned with the future than with the past. CHEMICAL & METALLURGICAL ENGINEERING has confidence in the ultimate adjustment of our present economic and financial dislocation. We conceive it to be our duty to contribute to that readjustment by rendering service that will enable American industry to attain a higher degree of efficiency than it has ever known. To this end we have determined to expand rather than contract our editorial activities. Two new engineers will be added to the staff and one of the present members will go to Europe for at least six months.

This will enable us to consummate plans that have long been cherished and which we believe will react greatly to the benefit of the chemical and related industries.

Two new features will be incorporated in the magazine: One relating to the economics of the chemical industry and the other to mechanical engineering in industrial processes. Qualified editors will devote their time to these activities. A survey of the economic and commercial factors that influence trade in chemicals and related commodities will appear each week, and an effort will be made to interpret financial and trade movements in their relation to the chemical industry. A more detailed statement of our plans will be found elsewhere in this issue in the department devoted to the subject.

The decision to pay more attention to the mechanics of industrial processes and methods of handling materials arises from a desire to supplement our excellent contributions on technology, industrial and scientific research with more articles from the field giving practical details of operation. A mechanical engineer experienced in construction and operation of chemical plants will be in charge of the work.

Sending an editor to Europe for six months should have many practical consequences of great benefit to our readers and advertisers. Through him we shall hope to reflect industrial conditions in Germany, Belgium and France and interpret them for the information and guidance of American manufacturers and consumers. Our future is inevitably bound up with that of Europe and it will only be through intelligent comprehension of conditions in the principal European countries as well as in our own that our industrial leaders will be able to chart their future business course. It will be our purpose to render some small service to this end by reporting at first hand conditions as our representative finds them.

Crumbs of Wisdom Out of the East

AN AMERICAN man of affairs was lately talking to a Chinese gentleman of the old school. The latter was robed in beautiful silk; he was a thoughtful person, but unconvinced that whatever comes out of the West is good for the East. The American was describing the Twentieth Century Limited, and explaining how in 20 hours he had frequently traveled from New York to Chicago, a distance of nearly a thousand miles.

"And when you arrived at Chicago, what did you do?" asked the gentleman of the East. The American could not remember.

Here is a point in philosophy that it may do us no harm to consider. The detached Oriental does not want to go from New York to Chicago except for a purpose, and if possible he would prefer to send some one else on the journey than to make it himself. This is with

no reflection on Chicago or the railway company and its facilities. If he were comfortably settled in Chicago, he would have the same objection to rushing to New York. He is rather more advanced than we are in the art of finding out what he wants and then in proceeding to enjoy it. Another of his merits is that he is less disposed than we are to run away from himself. Very often when we say "I've got no time to bother about" this or that or t'other thing we are seeking another occupation to avoid responsibilities and decisions that we are afraid to meet. What we Americans need to have drilled into us by some kindly mentor is to keep our eyes a little more firmly fixed on the goal, and to make less fuss about the incidents of our travel thither.

H. G. WELLS refers somewhere to a class of people he calls the "Godsakers"; meaning those who are constantly exclaiming, "For GOD's sake let's do something!"—without knowing what to do. We know very well how futile misdirected efforts are in chemical experiment. This is the very basis of research. But it holds true in nearly every walk of life. The nerve-racking haste to do indefinite things is what makes many of us old before our time, and spoils us for our old age as well.

The Chinese gentleman might give us profitable instruction in other respects. Politics are indeed in a bad way over there, but then the Chinese people do not lean on politics as we do to manage everything they can't manage themselves. We want to be let alone in our own business, but a considerable number of us seem to want the government to step in and regulate the other fellow to our profit. The Chinese is singularly free from such aspirations, for good and sufficient reasons.

Again, he is very loath to go to law. If he has differences with his neighbor, they take their quarrel to two or three of the old men of the community, who decide the matter for them with at least as great a measure of wisdom as a judge can do with several scrapping lawyers to handle. This provides an economical use for their old men, who are not cast aside as "back numbers" in the process. The Chinese are an ancient people with vast experience, and some of the things they know and which we neglect have the merit of truth.

Putting the Cart Before the Horse

THE young man failed to pass his examination in freshman chemistry. Some of us do not take incidents of that sort very seriously, but the freshman in question was one of a long line of persons eminent in scholarship. Cousins, father, uncles, first cousins once removed, grandfather and great-grandfather, all had been in the habit of taking honors. In the young man's case other marks were high, but chemistry was a failure. The father discussed the subject with a professional friend who is also of a scholarly turn of mind. And the sequel was a luncheon engagement between the latter gentleman and the boy.

"The trouble is," said the young man, "I don't believe what they say is so. There's this oxidation business, for instance, that sometimes means one thing and sometimes another. I am told to believe a whole lot of things that may be true and again they may not; but I can't see it. I am interested in what I can see or understand, but I do not believe the professor himself understands the line of talk that he passes out to us. If he does, why

doesn't he explain it? The thing does not seem reasonable to me!"

"I am glad," said the older man, "to find someone with a mind like my own. Chemistry really is a subject of immense interest, but from what you have told me they have not been trying to teach you chemistry; they have offered rather a sort of chemical theology. That you resent the teaching of whilom fancies about various chemical reactions indicates to me your good judgment, for you may be sure that in five or ten years from now many of these very fancies will be discarded." The ensuing conversation led into the field of descriptive chemistry, and here the young man immediately found his curiosity excited.

We know very well that we need philosophy all the time; we need to arouse our curiosity as to why things happen, and to keep this constantly alive, in all scientific work. But we venture to express the fear that there is a great deal of unilluminated teaching of the philosophy of chemistry, and this in such a manner as to kill the subject for the student.

Suppose we were discussing persons, and in response to your inquiry about JOHN DOE we were to send you his genealogical chart. It would not give you the information desired. We do not know enough about anybody alive to prepare a complete genealogical chart, and we don't know enough about heredity to compute a man's character, even if such information were available. It is so about things. We want to know why reactions take place, but this desire will remain inert unless our interest is aroused in the reactions themselves.

The way to get at chemistry is to see what it does, to watch its workings, to get imbued with the romance of it. Then students of a philosophical turn of mind will want to know the reasons why. Others will never get beyond the romance of it, because they lack the gift of philosophical curiosity. Here are, let us say, a hundred young men, taking freshman chemistry because it is in the curriculum. Only a few will follow it much further. The others will be interested or not; will get a sense of the subject in their minds so that they will know how to learn what they may want to understand later, according as we set the table for them. It should be a handsome display of what chemistry does; a descriptive display, to open the portals of their minds. Speculations as to the reasons why things happen should come later.

Why spoil the subject for fresh young minds by something that is very like theological dispute, when there is such a great store of beautiful things to show them? It looks to us as though some teachers of elementary chemistry are on the wrong tack.

Psychology in the Selection of Workers

ARE WE NOT neglecting the craftsman? In days gone by he was an important person, but in latter years it seems as though everything, inventors, employers and even his own fellows, had combined to obliterate him. The inventor in devising machinery has tried to get along as much as possible without him and to turn him, when and where he is needed, from a fashioner into a feeder. The employer would naturally rather pay feeders' wages than fashioners' and he has pulled in the same direction. The craftsman's unions, in seeking strength, have taken in the incompetents, and then have been compelled to demand that the work be made simple and easy enough for their incompetents to perform. The multiplicity of unions has also over-

lapped, and the result of this has been to restrict the variety of work that each member may perform.

At the present moment we are not discussing wages or living conditions, save as these are found in work. In this respect we venture the belief that variety is needed for human development. Psychologists have not yet achieved the art of making mental tests to determine exactly and fully how and in what direction a man may develop, but they have gone much further than most of us think. For instance, in one great manufacturing establishment that annually engages a considerable number of graduate engineers, it formerly required from one to two years to determine whether the young man should be guided: either into design, manufacture or sales engineering. Now by the aid of earnest study by trained psychologists they know as much of the native talent and capacity of the young men so taken on at the end of six weeks as they formerly did at the end of two years. Several life insurance companies now select their agents with the help of competent psychological study with a small fraction of the mistakes they formerly made in their appointments. A number of department stores, after long and serious study by competent and experienced psychologists of the problem of selection and administration of their personnel, have developed methods that result in such marked improvements in service that no less than 60 per cent of their charge customers have noted the difference.

Now if among such human material as seeks employment in department stores, the major portion of whom have not got beyond the eighth grade of grammar school, proper methods of selection and training make a great difference in the capacity of the sales forces, is it not time that the rest of us, who have other work to do than to sell tidies and needles and pins and yards of cloth, should begin to look over our staffs of workers?

Every one of us needs looking after, no matter what his position in an organization may be. If we are at the top, the chances are that the family doctor rules us with a far severer rod than the dispensary physician does if we run an elevator. In conferring lately with the head physician of a great college of technology we discovered that the young men of eighteen to twenty-two are really as tender as girls and that absurd little causes will often ruin the career of a young man unless there is an intelligent helper at hand to advise and reason with him and to guide him into ways that are wholesome for him.

How about the vast crowd of men, generically classed as "labor," with nobody to look after them, and of whom a disproportionate lot of splendid fellows are going to ruin and collapse for the reason that nobody does look after them? The union cannot give them mental tests and physical examinations, and nobody else does, and so thousands and thousands are eating their hearts out from some—to them—poisonous idea, or are making for tragedy with only an enlarged thyroid as the signal, and with nobody to know or care. If big department stores find it even profitable from the standpoint of business to engage psychologists in providing for the selection and administration of their forces of necktie men and passementerie women wouldn't it probably pay the rest of us to remember that all our employees are in our business family, and that in both selection and administration we should seek the best? And how do we know that in our own vanity the best is to be found? It would be abundantly worth while for a great many of us to look into the subject.

Wage Disputes In the Coal Industry

THE United States Geological Survey issues, without comment, a report on "strikes" in the coal industry in the twenty-one years 1899 to 1919 inclusive. As will be indicated later, it is possible that the subject matter of the statistics might better be referred to as "wage disputes" than as "strikes."

The showing indicates conclusively that something is radically wrong somewhere. This is distinctly the way not to do it. There is no statement of the total number of men engaged in the industry, and for that reason alone no direct comparison could be made, while the strike statistics are not complete, because they are compiled solely from reports of operators who produced in 1919.

As to the number of men involved in strikes or wage disputes, the latest year in the presentation, 1919, shows the greatest number, with 446,436 men losing a total of 15,693,567 man-days, equal to an average of 35 days per man, while 1910 shows the largest number of man-days lost, 19,250,524, or an average of 88 days per man for the 218,493 men involved.

Of the twenty-one years there were five in which more than 200,000 men were on strike at one time or another. A better appreciation of the importance to society of loss of working time is furnished by striking an average of the twenty-one years which shows approximately 6,000,000 man-days lost per year in the period, equal to 25 working days each for 240,000 men. In other words, the incomplete record of wage disputes in coal mining for more than two decades shows an equivalent of 240,000 workers being idle for one whole month each year.

Some of the twenty-one years showed much more lost time than others. In an effort to see whether the strikes had any connection with business conditions, we divided the years into good years and bad years commercially, using the production and price of pig iron as the criterion. The division made ten of the years bad and eleven good, but the ten years showing the greater amount of lost time fell in five good and five bad years, while the ten years of less lost time had the same incidence. Thus the strikes or disputes were not produced by good times or by bad times. Then another basis of scrutiny was taken, this showing that of the ten years of greater loss of time nine years were even-numbered years and only one, 1919, was an odd-numbered year. This was quite intelligible. For a long time past the bituminous wage scale has been biennial, the settlement falling in the even-numbered years. The exception, 1919, was a year in which men went on strike, claiming that the scale was a war-time scale and should not bind them since the war was over.

Thus it appears that the term "strike" is quite broadly applied. The time seems to have been lost chiefly during disputes as to the new scale. The customary procedure has been for the operators and the United Mine Workers to fail to agree prior to the April 1 of the even-numbered year on which the old scale expires. Then there is a cessation of mining, stocks of coal are exhausted, the market price of coal advances, and an agreement is reached. Somebody pays for the lost time, which incomplete statistics set at an average of one month a year for 240,000 men during twenty-one years. Not a few men have lately concluded that in the last analysis it is the general public that pays for this lost time.

Readers' Views and Comments

Wanted: Jingles of Science

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am endeavoring to collect verses of a more or less humorous nature, whose subject matter relates to the sciences, with the intention of publishing an anthology of such poetry, under the title "Jingles of Science." It has occurred to me that there may be a large amount of such poetry filed away by some of the great number of chemists, physicists, engineers and other scientific men of the country, which at the present time is quite unavailable to me, by reason of its non-publication. Will you kindly grant me space for this appeal to your readers to send me copies of such verses as are available to them, and which, in their opinion, are worthy of publication? Whenever possible, I should like to have the name of the author or authors accompany each contribution. Any verses, grave or gay, referring to any of the sciences, sent to me at 7 St. Paul St., Cambridge, Mass., will be sincerely appreciated and duly acknowledged.

Cambridge, Mass.

CHARLES E. RUBY.

Pitiable Plight of Russian Scientists

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Oct. 26 issue a very noble appeal was printed, urging American scientific men to lend a helping hand to those isolated and starving Russian scientists who still remain within the boundaries of the former state of Russia. As I am a Russian, I can most deeply appreciate the high motives of this appeal and urge that those of means might find some feasible way to help. But while I continually remember those brave men who are carrying on scientific research under incredible conditions of hardship, I make bold to raise my voice to help those who could not bear life in Soviet Russia and left the country with no well-defined aims or definite plans and without the means of leading a life such as would befit a man of culture.

Over two hundred Russians, people of brains and culture, who had followed the national armies of Denikin, Kolchak and Wrangel have met with this hard experience. You can meet Russian professors on the remote islands around Constantinople, you can see them working as clerks and laborers in the railroad depots of the Slavonic states, you can observe them in Egypt, in Greece, interned in the camps erected for war prisoners.

Many of them are with us no longer. Before me lies a long list (published officially by the Bureau of Russian Scientists' Society in Prague, October, 1921) which tells of man after man who found his peaceful rest.

Those dead have laid down their lives that their brothers might live. But these who remain alive are in conditions which even my national pride permits me to call pitiful. Many are separated from their families, deprived of everything but the right to breathe.

Here is not the place to mention how and where they earn their daily bread. Sometimes they do not earn it—because they are weak and ill and downhearted. But always they support their lot in uncomplaining silence. For them I raise my voice. They are within reach.

For them so much can be done. Not in the way of charity, but in the way of giving them a chance to work, to continue their researches which have elevated the name of Russian scientists so high and which in the past belonged not to Russia alone, but to all the civilized world.

Shall the world forget them now in the time of their need? Shall they pass out of our sight after all they have done for the world because their colleagues abroad did not proffer them aid?

Should any one desire to receive full information about the non-partisan Bureau of Russian Scientists the writer would be only too glad to give all the information at his command.

VSEVOLOD N. KRIVOBOK.

Dept. of Metallurgy,
Harvard University,
Cambridge, Mass.

Explosion of Agitator Charged With Naphtha

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Nov. 23 issue of your journal, W. H. Pape inquires about the cause of an explosion in an agitator which had just been charged with naphtha. It is a well known fact that oils of the nature of naphtha become charged with static electricity while being pumped through pipe lines, especially lines of small diameter. If this charge is not drained off through a ground wire, there is danger of a spark being caused by the discharge of the electrical charge contained in the naphtha. This is probably what occurred in the case he mentioned, the spark exploding the explosive mixture of naphtha and air above the liquid naphtha in the agitator. I would suggest that the pump lines to the agitator and the agitator itself be well grounded.

Wilson, Pa.

WALDEMAR VERNET.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Replying to the article of W. H. Pape on naphtha explosion in your issue of Nov. 23, I recall a similar case which came under my observation about 10 years ago. In that case the agitator was on a concrete foundation, the electric wires were in conduit, the acid, lye and air lines were bonded to the agitator and the charging line was connected to the bottom of the agitator. A batch of naphtha had been pumped up, and the line was being blown out with air when the naphtha exploded.

Experiments showed that the naphtha could not be ignited by blowing air through it—that is, by an overhead line. Then an iron line that had been filled with naphtha, to represent the agitator conditions, was tried. No results were obtained until the experiment was repeated on a damp, cloudy day, when the liquid at the end of the line ignited. This could be repeated under similar atmospheric conditions.

The conclusions were drawn that the explosion was caused by static electricity and the practice of blowing light liquid pumping lines was discontinued. Since then no such fires have developed. The conditions in the case mentioned may have been similar.

I. L. KLEIN.

Rossford, Ohio.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Dec. 4, 1921.

NOVEMBER was a month of uneasiness for those engaged in the chemical industries, as a proposed general reduction in wages threatened a strike of 200,000 workmen. However, representatives of both sides got together and owing to the fact that there was a large number of unemployed workers in Lombardy, Liguria and Piedmont were induced to accept a reduction of 1.65 lire from Nov. 1 to the end of February. This agreement has not yet been accepted by workers in other portions of Italy.

The demand for chemicals continued good and many reductions in price were avoided owing to the fact that Germany had prohibited the exportation of goods unless they had been contracted for in terms of Italian lire. This put an end to the speculation on the rise or fall of the German mark and increased the opportunities of other countries to do business, which were taken advantage of by France, England and the United States.

ITALIAN FERTILIZERS

The excessively dry weather of the fall months and the freezing weather that followed precluded the possibility of the usual rainfalls and discouraged the agriculturists from using fertilizers of all sorts. This was a serious matter for those interested in the manufacture and sale of such products, as they were left with stocks unsold and faced a fall in price. The latter is very probable, as measures have been introduced in Parliament aimed at forcing a reduction in prices, to encourage greater cultivation of the soil.

ITALIAN CHEMICALS

To encourage the manufacture of chemicals the customs officials have been authorized to waive the export prohibition on toluene, dinitrotoluene, lactose, chlorate of potash, tanning extracts, sulphate of copper and potash salts (excepting those required for agriculture). This was caused by the great success in the exportation of chlorate of potash, which amounted in the first 6 months of this year to 1,058 tons, 1,052 tons being destined to England. These exports were made after supplying the home market, only about half a ton being imported in this period. In the first 6 months of 1920 24 tons was imported and in the corresponding period of 1919 102 tons. Exportations of sulphate of copper also were very fair during this period, reaching 2,476 tons, against 4,116 and 800 tons in the corresponding period of 1920 and 1919 respectively. This product was distributed this year principally as follows: 1,190 tons to France, 358 to Yugoslavia, 11½ to Portugal and 700 to Rumania. Imports of sulphate of copper in this period reached only 598 tons, against 791 in 1920 and 35 in 1919. Of that imported this year 401 tons came from England and 57½ tons from the United States.

ITALIAN PURE ACETIC ACID

With the view of encouraging the greater use of pure acetic acid and increasing its production it has been decreed that manufacturers whose product is destined for industrial use will not be subject to the tax of 200 lire per annum which has been imposed on those manufacturers whose product is destined to be used for pharmaceutical or laboratory purposes. The imports of pure acetic acid of all concentrations during the first 6

months of this year were 109 tons, against 271 tons in the first half of 1920 and 85½ tons in 1919. Exports in the same period were 154½ tons in 1921, 110 tons in 1920 and 47 tons in 1919.

LIMITATION OF WORKING DAYS

The dry weather in November caused a scarcity of water power, consequently a limitation was placed on the operation of many manufactories, which were ordered closed for one, two or more days a week. This often interrupted their manufacturing operations and caused no end of trouble and loss. These conditions led the government to study a project for direct control of all hydro-electric plants in the hope of obtaining greater use than at present and of eliminating waste by better distribution of power. In the meantime decrees were issued aimed to increase the efficiency of plants producing electricity by other means.

ITALIAN SUGAR PRODUCTION

As the country produces scarcely enough sugar to satisfy the home demands, the government has issued new regulations regarding its importation, subject to the judgment of the Minister of Finances. Although the consortium arranged at Turin for the distribution of sugar has been eliminated and commerce in this article is now free, the government fixes from time to time the wholesale price.

Imports of sugar of first quality were large during the first half of this year, reaching 66,151 tons, against 5,146 tons in 1920 and 30,106 tons in 1919 during the corresponding period. Of this year's imports, 12,545 tons came from the United States, 6,103 from Belgium, 3,331 from France, 131 from Japan, 36,373 from the Dutch East Indies, 33 from Egypt, 2,149 from Brazil and 3,848 from Cuba.

HYDRO-ELECTRIC DEVELOPMENTS

It has been proposed to transport to Sicily a portion of the electric energy produced on the high plain of Sila, thus placing 50,000 kw. at the disposal of the island. It is proposed to erect stations at Cotrone, in the Province of Catanzaro, and carry the current on strong copper cable across the Straits of Messina to Catania, Caltanissetta and Palermo, a distance of 300 km. The Lys torrent, that descends directly from Mount Rosa to the River Dora, can furnish power for the four stations of Gressoney-Trinité, Chemonal, Gaby and Pont St. Martin. A fifth station is planned to utilize the waters of the Paconella, an affluent of the Lys. This station and that of Trinité would function only in winter, but the others could be used during the entire year.

The electric railway from Trofarello to Ronco will soon be completed, so that it will be possible to travel by electricity from Genoa to Turin. Other lines being electrified are the Ronco-Arquata-Tortona, the Turin-Novi, the Voghera-Bivio-Bormida and the Genoa-Ovada-Alessandria. It is hoped to finish soon the electrification of the Rome-Tivoli and Rome-Anzio-Nettuno lines, after which work for the service of express trains between Rome and Naples will be pushed. So by the beginning of 1923 it is expected that 500 km. of railways will be electrified, making the total in Italy 1,370 km.

As it takes from 18 to 21 months to construct an electric locomotive, the state railways has voted to order 120 at an expense of 169,000,000 lire. Some of these will be used on the lines now in operation and the remainder will be put on the new lines.

The Relations of the Iron and Steel Industry to the Chemical Industry*

The Steel Industry, an Important Consumer of Chemicals, Supplies Many of the Basic Materials for the Chemical Industry and With It Furnishes Our Chief Means of Defense as Well as Our Peace-Time Tools for Material Progress

BY JAMES M. CAMP

Director, Bureau of Technical Instruction, Carnegie Steel Co.

CLASSIFIED according to their direct relations to our natural resources and with respect to their dependence for raw materials, our industries are basic or subsidiary, according to the way they are grouped, and dependent. The basic industries are those engaged in the production, or creation, of raw materials by life processes, such as farming; or in the extraction of raw materials from the earth, such as mining or oil and gas-well drilling; or in the conversion of natural potential energy into useful forms, such as our hydro-electric plants. But these industries must be supplemented by a number of others, which, although they are directly dependent upon these basic industries for raw materials and mechanical power, are so intimately related to the former by reason of their being engaged in converting and adapting certain raw materials for use that they must be accepted as co-ordinate to these basic industries and also co-ordinate to one another.

under it are included such occupations as gardening, cattle raising, fruit growing and the growing of grain, also the sciences that relate to these arts. From this standpoint we are able to separate our industrial life into a number of divisions, which we shall term the subsidiary divisions of industry. For want of better names, we designate the basic subsidiary division devoted to the production of raw materials by life processes as the agricultural division; that devoted to the extracting of raw materials from the earth as the mining and well-drilling division; and that devoted to the transforming of natural energy as the hydro-electric division. As to the dependent subsidiaries, we call that one devoted to the separation and refining of the metals the metallurgical division; the one devoted to the preparation of refractories, bricks, all clay products, as well as glassware, etc., the earth-products division; and that devoted to the production of chemical compounds, the non-metallic elements and certain of the rare metals, the chemical division. Some of you may think of other industries that should possibly be included as another division, but we believe that any of our industries can be placed under one or another of these divisions.

INTERDEPENDENCE OF THE MAJOR DIVISIONS OF INDUSTRY

One of the things we wish to emphasize now is the close relation and interdependence of all these grand divisions of industry. So we would call your attention to the accompanying diagram, which will both demonstrate and vividly illustrate the point we wish to make. This diagram shows that these subsidiary divisions of industry are closely connected and related to one another because they are dependent upon one another for necessary raw materials and supplies, and are each made up of a number of related industries, so important that they are usually spoken of as being, themselves, the basic industries. Each of these industries is accompanied by a list of dependent industries so long that it was found impracticable to show them on this diagram. It is such a subsidiary division of industry, not a small branch of industry nor yet one of the dependent industries, that we have in mind when we refer to our chemical industry. It consists of the chemical industry proper and a great number of dependent industries, which, though they are not engaged primarily in the production of chemicals as such, produce articles of a chemical nature or by chemical processes, or articles that depend mainly upon chemicals. The chemical industry proper has, itself, three branches, which are known as the chemical section, the acid section and the coal-tar section.

Referring to the other part of our theme, we see in

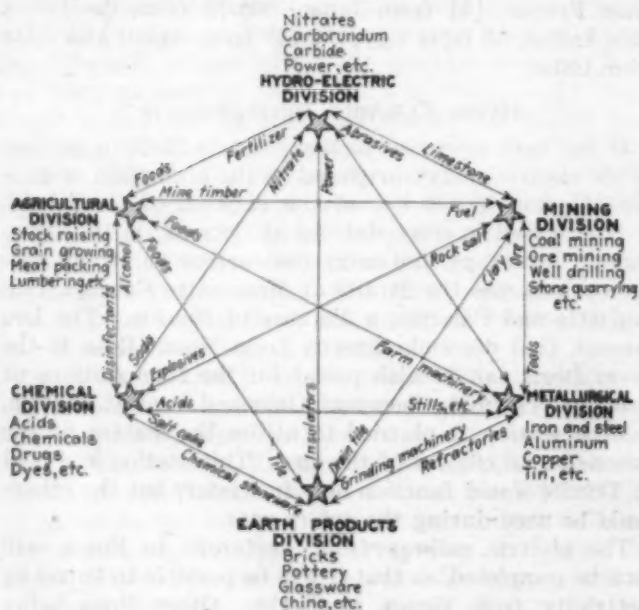


DIAGRAM SHOWING RELATIONSHIP OF THE SUBSIDIARY DIVISIONS OF INDUSTRY TO ONE ANOTHER

Hence, all these closely related industries are to be looked upon as being subsidiaries to our industrial life as a whole.

To explain more fully what we mean to imply by this use of the term "subsidiary" it is necessary to point out that we apply this designation to groups of closely related industries rather than to any specific activity. Thus farming, for example, is really a class term, for

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our country today a single branch of the subsidiary metallurgical division developed to such a high state of efficiency and on that account occupying such a high position commercially that it casts a shadow over the importance of even the subsidiary divisions. Such an industry is the steel industry. And here lies great danger for us, in that we may be led to attach too much importance to one industry or one division of industry and not enough to the others. Trying to decide which of these grand divisions of industry is the more important is like trying to decide which wheel of an automobile is most important, for they form the vehicle upon which our civilization is riding toward that goal set up for it from the beginning, when man was commissioned to replenish the earth and subdue it.

As the most important branch of the metallurgical division of industry, the steel industry cannot escape certain relations with the chemical industry, and it is interesting to note that these relations, both direct and indirect, are to an unusual extent interdependent. This interdependence is most vividly set forth when we consider these two industries from the standpoint of being consumers of each other's products.

STEEL INDUSTRY CONSUMES ONE-FIFTH OF OUR SULPHURIC ACID

In reviewing the chemical products consumed by the steel industry, we find that sulphuric acid heads the list both as to quantity and importance. Statistics showing the quantity of this acid consumed by the whole steel industry of this country have never been compiled. We do know, however, that during the year 1920 the United States Steel Corporation used approximately 280,400 net tons, all of which was concentrated to give, on an average, a gravity test of 60 deg. Bé. This fact leads us to the confident belief that our steel industries as a whole must have consumed last year at least 600,000 net tons of this acid, expressed on the standard gravity basis of 50 deg. Bé. To make a striking comparison, the acid consumed during the year 1919 by the Steel Corporation alone amounted to almost 10 per cent of the total quantity of this acid reported by the Census Bureau as having been made in this country that year.

Of this acid used by us, nearly one-half finally went into the manufacture of ammonium and iron sulphates and thus represented a recoverable outlay, but the remainder represented an actual consumption, from which there was no such recovery of acid or any other direct tangible return for the outlay. As to the direct purposes to which we put the acid, not used in the manufacture of ammonium sulphate, a small portion was used in washing benzene and other homologous compounds produced by byproduct coke plants, a smaller portion was consumed in making chemical analyses, and the remainder was employed for pickling. The pickling process consists in immersing the steel in a warm dilute solution of the acid, and has for its purpose the removal of scale from the surface preparatory to tinning, galvanizing, cold rolling, cold drawing or chipping.

Concerning the necessity for pickling, this operation is absolutely essential in the manufacture of steel wire, of tin and terne plate, of galvanized sheets and tubes, of cold-drawn seamless tubing, and of all sheets requiring a highly finished and polished surface; and, as a means of revealing surface defects in billets and blooms, it is a great aid in the manufacture of high-grade steel, such as that required for forged and heat-treated

articles. Other agents could be used for some of these cases, but the cheapness, chemical activity and high volatilization temperature of sulphuric acid make it the most satisfactory reagent that can be employed for this purpose.

The next items in point of quantity consumed by our corporation during the year 1920 were muriatic, or hydrochloric, acid and sulphur itself. Of the 10,200 net tons of the former consumed, some was used for pickling in processes where sulphuric acid is not suited to the conditions, such as the final pickling in galvanizing; some was consumed in our chemical laboratories, where it is used in practically every analysis made; some was neutralized with zinc to form part of the flux used in the manufacture of tin and terne plate; and a small portion was applied to various other purposes too numerous to mention here. The greater portion of the 22,000 net tons of sulphur used by us was consumed in the manufacture of sulphuric acid, which we also make as a byproduct in zinc smelting, but a considerable portion was employed in the manufacture of certain grades of steel, in the galvanizing of sheets and in the erection of acid-proof water-tight brick tanks.

The fourth and fifth items next in importance are sal ammoniac, or ammonium chloride, and soda. During the year 1920 our corporation required almost 7,500,000 lb. of sal ammoniac and a little more than 1,120,000 lb. of soda, most of which was in the form of the hydroxide, commonly known as caustic soda, and the remainder in the form of the carbonate, or soda ash. The sal ammoniac was used chiefly as a flux in the application of tin, terne and zinc coatings, but a small quantity was consumed in the laboratories and shops, where it is indispensable in some work. With the exception of small amounts used in our laboratories and for cleaning purposes the soda was employed in our plants for the neutralization of acids and corroding compounds, such as in the washing of benzene products and the softening of water for boiler use. Its effectiveness and the importance of its use for these purposes are matters that need not be elaborated upon nor emphasized here.

OTHER CHEMICAL REQUIREMENTS

Other items that may be of interest to certain organic chemists are the 6,000,000 lb. of palm oil used in the tin-plate plants of the corporation during 1920, the 63,477,000 gal. of fuel oil consumed, and the 3,264,000 gal. of straw oil required for the absorption of benzene and its homologs from our coke-oven gas. Tar oils may be substituted for the straw oil, but no satisfactory substitute for the palm oil has yet been found, though such a substitute has been diligently sought.

A small item is nitric acid, of which we consumed nearly 6,000 lb. in 1920. The use of this acid is restricted to laboratory purposes almost exclusively. During the same year our requirements for the nitrate of soda called for more than 3,500,000 lb. of this salt, most of which was employed in the manufacture of sulphuric acid.

Next comes a long list of chemical articles for which we have no data whatever as to the quantities consumed by the steel industry. Their importance, however, is apparent as soon as they are named or the uses to which they are applied are indicated. This list includes the various chemicals used in our laboratories for analytical purposes, and such substances as lubricants, soaps, salt, carborundum and compressed oxygen. From 1,000 to

1,200 lb. of elementary phosphorus is also consumed in the preparation of phosphor bronzes for use by the steel manufacturers.

THE CHEMIST AS A PROSPECTIVE CUSTOMER

Not only are the iron and steel industries large consumers of chemicals, hence good customers of the chemists, but the chemical industries are likewise large consumers of iron and steel. We have been unable to obtain statistics as to the tonnage of iron and steel used by our chemists, but, judging from our knowledge of these industries, we know it must be large. The chemists deal largely with matter in the liquid and gaseous states, hence their apparatus consists of such vessels as stills, retorts, vacuum driers, pipes, tanks and various other containers, many of which are made of iron or steel entirely, while the remainder require these materials in their construction. They have need of much steel in the form of plates and sheets for vessels, ranging from tin cans to tank cars, in which to transport and market their materials. They employ much machinery, such as fans, rolls, pumps, presses, crushers, disintegrators and centrifugal machines, and, of course, require engines and motors to operate these machines. They require steel for their buildings, which usually must be fireproof; in 1919 there were more than 1,300 establishments producing chemicals, 811 of which were devoted exclusively to the chemical industry proper.

SOME WASTE PRODUCTS OF THE STEEL INDUSTRY

But it is in the sense of a prospective customer that the steel industry should show the keenest interest in the chemical industry, for the former has, to a considerable extent, gradually worked itself into the position of a producer of certain chemicals and raw materials for the latter industries. Thus during the war the scarcity and consequent high price of potash brought about the installation of apparatus for the recovery of this product from the dust in blast-furnace flue gases wherever the amount of potash driven over with these gases would justify the expense. Similarly, a desire to eliminate waste led the steel industry several years ago to begin the manufacture, from spent sulphuric acid, of ferrous sulphate, commonly known as copperas or green vitriol. The production of this salt for the year 1919 amounted to almost 60,000 net tons, practically all of which we can be reasonably sure was produced by the steel industry.

This salt is used in paper making; in the tanning of some leathers; in water and sewage purification; in the manufacture of fertilizer from packing-house waste; on the farm as a spray and disinfectant for the eradication of weeds and the prevention of certain diseases among plants and animals; and in the preparation of inks, certain pigments, shoe blacking, ferric sulphate, stock foods and a few drugs and medicines. A new use for this salt has been found in the briquetting of blast-furnace flue dust, in which process it acts as a cement, making the briquets produced by pressing hard and strong. It is also used in the purification of artificial gas from hydrogen sulphide and hydrocyanic acid gases, for which purpose there are two general methods, known as the dry and the wet methods. In the dry processes the sulphate is mixed with equal volumes of lime and moist sawdust, which are then pressed into a cake and roasted. The roasting burns out the sawdust and leaves a porous mass composed of iron sesquioxide and lime intimately mixed and ready to be charged into the gas

scrubber. In the wet processes, which are more efficient in the removal of hydrocyanic acid, the gas is scrubbed with a concentrated solution of the sulphate, and ferrocyanides are obtained as byproducts. A lime and iron oxide mixture similar to that just described for the dry process is now obtained by one of our companies in the purification of mine waters. As this mixture does not require roasting, it is easier to prepare than the sulphate mixture and is very effective and economical as an agent for removing sulphur in coke-oven and other retort gases made from coal.

It should be noted in passing that a similar desire to utilize what would otherwise remain waste products urged us many years ago into the manufacture of cement from blast-furnace slag, of phosphate fertilizer from basic slag, and of paints containing zinc oxide and white lead or iron sesquioxide as base pigments. Although viewed with much prejudice and suspicion in the beginning, the high quality and economic importance of these byproducts of the steel industry are now generally recognized.

SUPPLYING AMMONIA AND COAL-TAR PRODUCTS

Again, the change from the beehive to the byproduct method of coking coal has brought the steel industry into the most intimate relationship with the chemical industries, particularly the coal-tar branch. This change has created an almost unlimited supply of ammonia and coal tar, the chief raw material used by the coal-tar chemists. Ammonia can now be produced at the byproduct plant in three forms—namely, as ammonium sulphate, as concentrated ammonia liquor and as ammonium chloride. The chief outlet for this ammonia lies in the direction of the fertilizer industry, for which purpose the sulphate is employed. The salt is seldom applied alone to the soil, but is used in the various fertilizer mixtures, for which purpose it is well adapted because it will neither revert the acid calcium phosphate nor react with the other fertilizer ingredients to render unavailable any part of its own nitrogen content. It is especially beneficial to some of our soils which contain an excess of the alkalis and to other that lack sulphur. In the latter it fulfills the double purpose of supplying both nitrogen and sulphur, two elements essential to plant growth. A process for recovering ammonia in the form of the chloride, which happens to be the form in which about 90 per cent of the fixed ammonia is given off by the coal, has been recently developed so as to be applied on a large scale. The perfecting of this process will make it possible to produce this salt in large quantities and possibly in a highly refined state. Thus another element has been added to the list of coke byproducts, and the field for the disposal of byproduct ammonia has been widened.

Omitting alcohol and the compounds of sulphur and hydrocyanic acid that can be made or recovered from coal gas, the other products of the byproduct plant are the chemical compounds benzene, toluene, xylene and naphthalene, and the mixtures known as light-runnings, wax, resin and tar. Commercially, the first three compounds, as well as mixtures of these substances, are known as benzol, toluol and light and heavy naphtha. These compounds, together with tar, form the raw materials for the coal-tar branch of our chemical industries. The finished products that can be made from these raw materials are numbered by hundreds, but, classified, the finished coal-tar products consist of dyes, color lakes,

explosives, disinfectants, medicines, phenolic resins, flavors, photographic chemicals and perfumes, in about the order of their total money values per annum. According to the statistics compiled by the Census Bureau, the weight of these products for 1919, excluding disinfectants and explosives, amounted to 82,532,400 lb., and they were valued at \$84,515,500, or an average price per pound for all finished products of about \$1.05. A comparison of this average price with the 1919 prices obtained for the crude products at the coke works, which ranged from 2c. per lb. for tar to 10c. for the purest naphthalene, shows how the values grow in passing through the hands of a chemist. In addition to these finished coal-tar products, there were produced in unknown quantities several crude and intermediate products, the total value of which is stated to be approximately \$49,000,000.

THE RISE OF THE COAL-TAR INDUSTRY

At this point it may be of interest to note the rapid growth of this branch of our chemical industries. In 1914 the total value of all the coal-tar chemical products produced in this country was approximately \$9,000,000, and with the exception of tar refiners and about seven small plants engaged in assembling imported intermediates into dyes, there were no establishments devoted solely to the manufacture of finished coal-tar products of any kind. Now, according to the recent census taken by the United States Tariff Commission, the total number of firms engaged in the manufacture of coal-tar products in 1920 was 213, of which 82 were engaged in the manufacture of dyes alone. These firms produced more than 206,000,000 lb. of the semi-finished products known as intermediates and more than 67,000,000 lb. of finished dyestuffs. The discrepancy between the tonnage of intermediates and finished dyes is brought about in two ways—namely, some of the intermediates are produced from other intermediates, hence may appear twice in our total, while others may be used for the manufacture of other substances than dyes. All of these intermediates can be made from benzene, toluene, xylene and naphthalene, and are very numerous, as many as 46 being derived from naphthalene alone. Concerning the number of dyes, our chemists made 360 separate dyes in 1920, some of which were never made before. We hesitate to give any figure as representative of the number of other coal-tar chemicals, for new ones are being discovered with bewildering frequency. If we can do so without appearing unduly boastful, we would like to declare in this connection that American chemists during the past 5 years have led the world in the discovery of new coal-tar chemicals.

Another comparison of perhaps greater interest to us is this: The 82,500,000 lb. of finished coal-tar chemical products produced in this country during the year 1919 is equal to only a little more than one-third of the total weight of the benzene products and less than one-tenth of the tar produced by the Steel Corporation alone during the same period. Now, the processes of the coal-tar chemist are all synthetic, so that his finished products generally show a gain in weight over the basic raw materials, except in the case of tar, of which only about 15 per cent is available for synthetic purposes. So, keeping in mind that the Steel Corporation probably made considerably less than half of all the tar and primary benzene products produced in this country, we have evidence enough that the production of coal-tar

chemicals was not limited by a scarcity of raw materials. Yet, for this reason or that, we have found the coal-tar chemists importing some of these same raw products.

NEED FOR BETTER RELATIONS BETWEEN THE TWO INDUSTRIES

Let us cite one case to illustrate a point we wish to make. A certain byproduct coke plant operator, under the impression, which he had gained in dealing with the coal-tar chemists themselves, that for the manufacture of certain naphthalene dye intermediates the purest naphthalene obtainable was required, proceeded to install at great expense apparatus wherewith he would produce practically c.p. naphthalene, or at least naphthalene with melting and boiling point ranges of 1 deg. This gentleman then felt reasonably sure of getting a good portion of the business in high-grade naphthalene, but less than 2 months after completing his fine new plant he found his best customer importing naphthalene at 3c. less per pound than he was asking—yes, but of inferior grade and with a boiling point range five times as great. Now, either this dye maker had intentionally misrepresented his requirements with the idea of getting something for nothing, if he could, or he suddenly discovered he did not need as good a grade of naphthalene as he thought. This incident illustrates a lack of sympathy and co-operation between these two industries that we hope is, or will soon become, very rare.

Fortunately, and also unfortunately, the steel industry does not rely upon the coal-tar chemical industry in disposing of these coke byproducts and neither does the coal-tar chemical industry rely upon us for its supply of raw materials entirely. The steel industry finds a ready sale for all its benzene and toluene and a part of the naphtha as motor fuel, while the remainder of the naphtha and all of the naphthalene and tar can profitably be used as fuel in the steel mills. On the other hand, the coal-tar chemists can look to the gas manufacturers for many of their basic raw materials, and, indeed, so far as the refining of tar is concerned, they rather prefer certain gas tars to coke-oven tar, as the former usually contains a higher percentage of the more desirable light and middle oils. This is the unfortunate side of this condition, that it does not promote the spirit of sympathy and helpfulness that goes with a mutual dependence. All tar, however, contains a high proportion of pitch, for all of which it is difficult to find a ready market. But the coal-tar refiner would be relieved of his "burden of pitch" and the byproduct coke operator would receive more money for his tar, if some plan were evolved wherein the tar could be roughly fractionated at the coke plant, where the pitch could be mixed with raw tar and used as fuel or charged into ovens and converted into coke.

SOME INDIRECT RELATIONSHIPS

Leaving for a time the points of direct contact between these two industries, let us examine briefly their indirect relationships. For, whether the matters just discussed are viewed with concern, as being of importance, or with indifference, as becomes trifles of little consequence, the steel and chemical industries are indirectly connected in ways that are vital to the welfare of both. To prove this statement the mere mentioning of a few of these direct relationships is all that is needed.

One of these indirect relationships has to do with the

fact that certain products of these two industries are absolutely interdependent for their effectiveness. We consider, for example, the dependence of liquefied and compressed gases upon the high-tension seamless steel tank, and then reflect that without the development of and the demand for such gases there would be no demand for the tanks. In the latter case the steel industry would have missed a good business, for, taking the case of compressed oxygen alone, the 1,200,000,000 cu.ft. or more of this gas compressed yearly requires the constant use of about 2,000,000 tanks to contain and market it. Similarly, we find steel tubing and ammonia working together in our ice plants, drills and powder in our mines, firearms and explosives on our battlefields and on our hunting grounds, and automobiles and gasoline or benzene everywhere.

Again, we find that the steel and chemical industries are connected in a similar indirect but vital manner through their more direct relations to certain other industries. In a word, both steel and chemicals are first essentials to many industries. We have already pointed out the interdependence of our basic subsidiary industries, upon which all our other industries depend, and now we wish to call your attention to the fact that some of our most important special industries are so completely dependent upon steel and chemicals that if they were denied either of these two classes of materials, these industries would be totally ruined. A notable example is supplied by the electrical industries. Without chemicals for batteries and insulating materials, or without steel for magnets, armature cores, transformer cores and other vital parts of electrical machinery, the whole industry would be handicapped and certain branches would be impossible. Similar conditions with respect to steel and chemicals prevail in the telephone and telegraph industries, the textile industries, the rubber tire industry, and in many other industries of more or less importance.

OUR NATIONAL SAFETY AND OUR INDUSTRIAL PROGRESS DEPENDENT UPON STEEL AND CHEMICALS

Before leaving our subject we would speak of one other phase of the indirect relations between these two industries. This matter, while it is less tangible than those things we have just been discussing, is nevertheless of vital importance. We refer to the common relation of the steel and chemical industries to the welfare and safety of our country. It is self-evident that the strongest nation is the independent nation—that is, the nation that does not have to rely upon its neighbors for any of the basic or critical supplies. Such an independence is based upon two commodity factors—namely, natural resources and the industries to develop them. As to the natural resources, this country has been blessed with a full line with the exception of combined nitrogen, which deficiency, fortunately, can now be supplied by our by-product coke ovens and our prospective nitrogen-fixation plants. Fortunate for us, also, we can now say, although not with pride, since we were forced to it, that the last link in the chain of our industrial independence has been forged. This link is about to be subjected to the severest commercial tests, and whether or not it can withstand the tension of selfishness, prejudice and ignorance at home and the strain of competition from abroad depends upon how big a load we permit these things to become.

This new link in our industrial chain you will recog-

nize as the coal-tar branch of our chemical industries. Its present importance to us in peace times is indicated by the value of its products for 1919, which we have just stated. Its future importance we can only imagine, for it is still in the rough and capable of much further development. Indeed, none of our other industries presents such a field of unexplored potentialities. For its importance in war times, we need only to refer to its position in the late World War. If Germany ever again is the maker of our dyes, German poison gas will again suffocate our soldiers. To overcome prejudice and misrepresentation at home, let all our people know we can and do make as good dyes as were ever made prior to the war. Dyes, like the different varieties of steel, can be misused and also injured by the way in which they are applied. The excuse we so often hear that our colored textiles fade because they are dyed with American dyes is a fallacy that may cover either cupidity or ignorance in the proper use and application of our dyes. To overcome the mistakes of ignorance, which, by the way, are mainly of a commercial nature and not of the technology of coal-tar chemistry, requires time, experience and the closest co-operation of all those concerned. Since they compose the two groups that would be most seriously affected by the destruction of this industry, the last part of this statement should be especially emphasized among both the makers and the coal-tar chemists, who, we fear, are not always so frank and business-like in their dealings with us or with the public as they should be, for their own good.

While we maintain that all our industries are equally important to the physical comfort and general welfare of our people, we can also say that no others have contributed so much to our safety and progress as the steel and chemical industries. In times of war they have supplied our chief means of defense and in times of peace they have furnished us with tools wherewith we have hewn our way to material successes. And now we plead for more sympathy and co-operation in these industries to the end that each may continue to contribute more and more to the security and prosperity of our own nation and to the advancement of all mankind.

Pittsburgh, Pa.

Italian Olive Oil Industry

The Italian Government is considering a project for joining all the growers of olive trees into an association to do away with antiquated methods of cultivation, reports the special correspondent of CHEMICAL & METALLURGICAL ENGINEERING. The association is to be maintained by the payment of a fee varying according to the number of plants cultivated by each member.

The Italian exports of green olive oil during the first half of 1921 were 1,894 tons, against 798 tons in the corresponding period in 1920 and 416 tons in 1919. Of these, 621 tons went to the United States, 92 to France, 137 to England, 53 to Switzerland, 10 to Australia, 26 to Tripoli, 110 to Argentina, 38 to Brazil, 17 to Chile and 20 to Uruguay.

The Italian imports of green olive oil in the first 6 months of 1921 were only 4 tons. Imports of edible, or pure, olive oil were 2,441 tons, against 814 tons in the first 6 months of 1920 and 5,720 tons in the corresponding period of 1919. Of the edible product imported in the first half of 1921, 203 tons came from Greece, 328 from Spain, and 1,239 from Tunis, the remainder being divided among other countries.

Manufacture of Cellulose Nitrate for Pyroxylin Plastics

Preparation of Tissue Paper or Linters for Nitration—Methods of Nitration: The Pot Method and Its Modifications; Nitration in Centrifuges; the Displacement or Thomson Process—Purification of Cellulose Nitrate: Washing; Pulping; Bleaching; Drying by Various Processes

By J. R. DUPONT

AS A general rule, pyroxylin plastics are prepared by mixing a certain grade of cellulose nitrate with camphor and denatured alcohol. Sometimes for the sake of economy the camphor and alcohol are replaced partly or entirely by substitutes which will produce a more or less perfect plastic. Pyroxylin plastics are usually marketed under a trade name such as celluloid, viscoloid, pyralin or fiberloid.

Of the many possible cellulose nitrates, all of which have the general formula $C_{12}H_{10-n}O_{20-n}(ONO_2)_n$, only those having a nitrogen content of from 10.5 to 11.4 per cent are used in the manufacture of pyroxylin plastics. These are generally known as nitrocellulose, pyroxylin or soluble cotton, and their manufacture is a highly specialized operation, since the properties of the finished plastic are largely dependent upon those of the pyroxylin used.

TYPES OF CELLULOSE USED AS RAW MATERIAL

Many kinds of cellulose have been recommended for the preparation of cellulose nitrate to be used in making pyroxylin plastics, but so far, in Europe and in America, only two are used: tissue paper and cotton linters. The tissue paper is made of specially prepared and bleached cotton rags, weighs from 20 to 25 g. per square meter and has a thickness varying from 0.0025 to 0.0035 in. It has to be of very uniform composition and color, free from specks, hard knots or sizing, and is delivered to the plastic manufacturer in rolls weighing from 200 to 300 lb.

For use in this industry, cotton linters are submitted to a special purification to remove dirt, hulls and grease, and they receive the best bleaching possible, keeping in mind that an excess of treatment will be prejudicial to the quality of the finished product. So far in this country tissue paper has been mostly employed, but in Europe cotton is quite often used, and by employing proper acid mixtures cotton gives as good cellulose nitrate as paper. From an economical point of view it seems probable that in the future linters will supplant paper in the manufacture of pyroxylin plastics, as the cost of the former is about one-third that of the paper. Of all other different kinds of cellulose tried (flax, wood pulp, etc.), none so far has been utilized because of too poor nitration obtained or too colored nitrates produced.

DRYING OF CELLULOSE

As received the tissue paper or cotton has a moisture content too high to permit direct nitration, consequently it has to be dried before being used. This drying operation is very important, as too much moisture in the cellulose (above 1 per cent) will cause the following troubles: Weakening of the acid bath;

irregular nitration, which will give a poor solubility; low yield caused by the breaking up of the cellulose nitrate fibers as a result of the rise of temperature produced by the contact of water with the acids; production of muddy acid, which will be prejudicial to the making of a first-class transparent plastic; acceleration of the production of N_2O_5 , which will affect both the yield and the stability of the cellulose nitrate.

Drying the tissue paper is ordinarily done after it has been cut into strips of various sizes, which are carried by air displacement into a closed room, where, by hot air circulation, the drying is effected. In the case of cotton, the drying is done by placing the carded linters in heated and ventilated chambers, where they stay a variable time according to the moisture content, the temperature of heating and the efficiency of the ventilation.

Linters may be dried more efficiently in continuous driers similar to those used in the textile industry, since these give a greater production and also more uniform drying.

NITRATION BATH

The nitration bath is formed from a mixture of nitric and sulphuric acids in variable proportions, and each factory has adopted a special formula which gives the best results for a determined cellulose. In general the ratio of nitric to sulphuric is about 1 to 3. This corresponds to a percentage composition of: HNO_3 , 19 to 20; H_2SO_4 , 60 to 61; H_2O , 21 to 19.

Table I shows the results of laboratory research on different nitration baths. These data were ob-

TABLE I. LABORATORY RESULTS WITH VARIOUS NITRATION BATHS

No.	Mixed Acid				Temp., Deg. C.	Time, Min.	Cellulose Nitrate Solubility in:			
	HNO_3 , Per Cent	H_2SO_4 , Per Cent	N_2O_5 , Per Cent	H_2O , Per Cent			Yield, Per Cent	N , Per Cent	5 Per Cent Camphor	Acetone
1	20.68	60.54	0.89	17.89	30	30	165.6	11.44	96.3	98.8
2	17.03	64.69	Trace	18.28	29	30	161.8	11.21	98.2	99.8
3	17.03	63.95	....	19.02	30	30	161.6	11.00	97.7	99.9
4	17.46	63.96	....	18.56	29	32	161.4	11.02	92.8	99.6
5	16.87	64.15	....	18.98	30	30	156.9	11.05	98.1	99.8
6	16.52	64.89	....	18.69	31	30	160.5	11.16	99.1	99.9
7	16.04	64.08	....	19.88	30	30	155.7	10.83	99.7	99.9
8	15.91	64.96	....	19.13	29	30	156.2	10.82	94.9	99.7
9	15.64	64.00	....	20.36	29	31	153.0	10.14	97.9	99.8

tained on paper using 50 g. for each nitration, with a ratio of acids to paper of 100 to 1. As would be expected, in practice the yield obtained after washing and bleaching is considerably lower and is around 145 to 148 per cent.

TIME OF NITRATION

The nitration time is variable according to the composition of the mixed acid, the kind of cellulose used

and the temperature of the acid. In case of tissue paper the speed of reaction is in direct proportion to the thickness and also to the temperature at which the nitration is conducted. For economical results the time of nitration is rarely over 60 minutes—that is, the total duration, including the filling of the pots with acid, the dipping of the paper and the whizzing of the cellulose nitrate. This leaves the real time of nitration varying from 25 to 35 minutes, which is enough if the composition of the mixed acid is correct.

For linters a longer time of nitration is generally employed, but by increasing the temperature of the acid, which will speed up the reaction, practically the same time can be used.

TEMPERATURE OF THE MIXED ACID

The temperature of the acid varies according to the cellulose used, and each manufacturer has adopted a temperature which gives him the best results. When working with tissue paper the acid temperature is kept around 30 deg. C.; with linters near 35 deg. C. The higher the temperature of the acids the quicker will be the reaction but also the greater the chance of breaking up the fibers of the cellulose nitrate formed, which will lower the yield.

Combined with too much moisture in the cellulose, excess of heat will produce partial decomposition of the cellulose nitrate. Not only is this practice, often observed, a costly one, but also the acid is soon contaminated with N_2O , which, in amounts above 1 per cent, will affect the yield and lower the stability of the cellulose nitrate produced. The most trouble arises during the period of warm and damp days when it is difficult to keep down the acid temperature and artificial cooling has to be employed.

QUANTITY OF ACID USED

The type of cellulose and the method of nitration have a direct influence upon the amount of mixed acid required for nitration. With tissue paper the ratio of acid to paper is generally 100 to 1, but if the paper is stirred during nitration the proportion can be reduced to 85 to 1. In the case of linters the ratio is usually between 50 to 1 and 60 to 1.

TYPICAL PLANT DATA

Table II gives data which are typical for the commercial production of cellulose nitrate from tissue paper and linters.

NITRATION METHODS

Three general methods of nitration are employed in pyroxlin plants: Pot method, centrifuge method and displacement process.

POT METHOD

Hand Dipping With Individual Pots.—In this first method, which was much used in the early days of celluloid manufacture, the dry cellulose was dumped in stoneware pots containing the mixed acid; after nitration, which required from 45 minutes to 2 hours, the cellulose nitrate was separated from the spent acid by different means, but all based on exerting pressure on the cellulose nitrate. After most of the acid was thus expelled, the nitrate was drenched in water. As the loss of spent acid was very great and owing to the difficulty of washing the compressed cellulose nitrate,

the next step was the introduction of the centrifuge as a means of separating the spent acids from the finished product, a method which is practically the only one used today.

The capacity of the pots used at first was only 8 to 10 gal.; as the production was small, the capacity was later increased to 100 gal. The small pots were ordinarily carried by hand to the acid-extracting machine, but as the larger ones were too heavy, they were made stationary, supported by two iron posts. By a cock the acid was drained off after nitration and the cellulose nitrate forked into the whizzer. The abundant fumes obtained during the process were collected by a hood and carried outside by a fan.

Table Method.—In order to get a greater production and reduce to a minimum the size of the nitration room, the pots were placed on a turntable, and this table method (which was first designed by Hyatt) is still used with but very little modification.

The apparatus is composed of a circular turntable upon which six or eight iron pots of special shape are supported by iron arms. Outside the table is a whizzer so placed as to reduce to a minimum the splashing of the acid when the pots are dumped. Above the pots and the whizzer is a large hood where the fumes are collected and sent outside by a suction fan. The apparatus is operated as follows: The first pot is filled with mixed acid at the proper temperature and the dry cellulose is placed by hand in the acids and dipped with aluminum forks or by a specially constructed stirrer; this done, the table is turned by hand so that the second pot is placed in front of the acid feed pipe. The second pot is then filled with acid, the dry cellulose immersed and the operation repeated. The number of pots on the table is determined by the duration of the nitration, so that when the last pot is ready to be filled with mixed acid the nitration of the first is completed and it can be dumped in the whizzer. With an average of 45 minutes for

TABLE II. TYPICAL PLANT DATA

Composition of mixed acid:	Nitration of:	
	Tissue Paper	Linters
HNO_3	21.13	19.59
N_2O_4	0.32	0.21
H_2SO_4	60.54	60.70
H_2O	18.01	19.50
Ratio of acids to paper or linters.....	90.1	60.1
Temperature of nitration, deg. C.....	30	35
Duration of nitration, minutes.....	30	30
Total duration, minutes.....	45	45
Yield, per cent.....	148.2	149.3
Nitrogen content, per cent.....	11.29	11.34
Solubility in 5 per cent camphor alcohol solution, per cent.....	98.7	99.4
Solubility in acetone, per cent.....	99.7	99.8
Viscosity, seconds.....	95	74
Analysis of spent acid:		
HNO_3	19.70	18.80
N_2O_4	0.40	0.30
H_2SO_4	60.12	60.21
H_2O	19.78	20.69

the total time of nitration, using eight pots, a complete turn of the table takes place every 45 minutes, each operation taking the following time: Filling the pot with acid, 3 minutes; dipping of the cellulose, 4 minutes; duration of nitration, 31 minutes; dumping and whizzing of the cellulose nitrate, 5 minutes.

As the pots have a capacity varying from 15 to 30 lb. of cellulose, the production per hour varies from 232 to 464 lb. of cellulose nitrate, admitting an average yield of 145 per cent. As to labor, six men are required to take care of the table. This method of nitration, used in the United States principally for the nitration of tissue paper, has the following disadvan-

tages: Irregular solubility of the cellulose nitrate due to the fact that the cellulose is generally dipped by hand with no stirring during the nitration; great loss of nitric acid fumes, as the pots are not covered. In addition, the fumes are very troublesome for the men and keep the cost of repairs very high. For these reasons the table system of nitration is generally re-

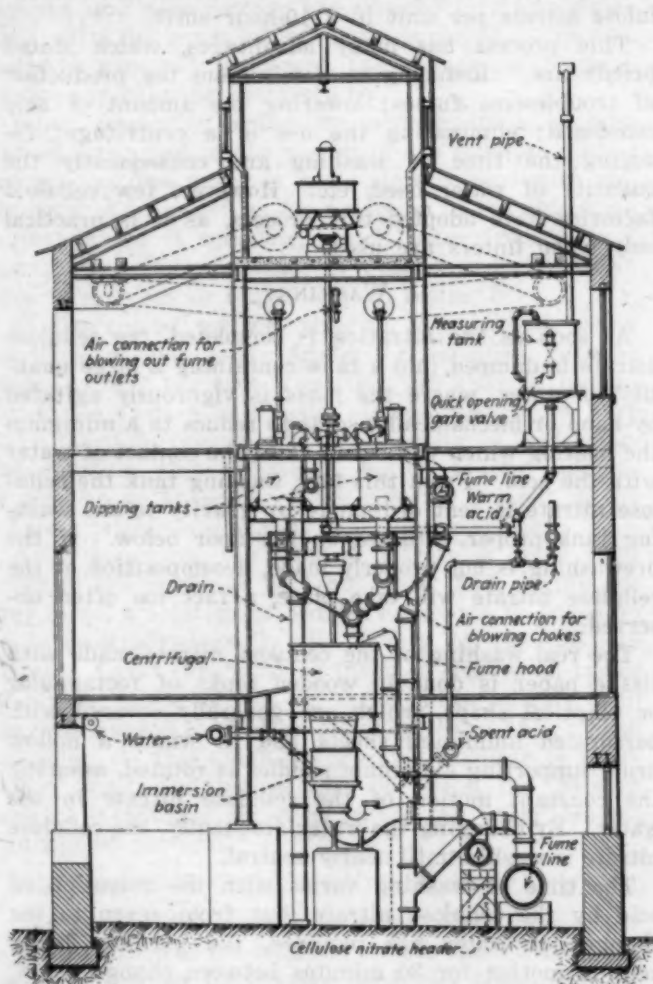


FIG. 1. CELLULOSE NITRATE PLANT USING MECHANICAL DIPPING TANKS

placed by the use of special nitration units as used in the manufacture of cellulose nitrate for the making of explosives.

Mechanical Dipping Tanks.—This special machinery is composed of four separate dipping tanks and one centrifuge, forming one unit. Each tank (which is made of special acid-resisting iron) is cylindrical and provided with two stirrers which not only stir the cellulose during the nitration but effect the dipping of the cellulose when placed in the acids. Situated at the bottom of each dipping tank is a pipe of large diameter closed by a valve, connecting the tank with the centrifuge which is situated on a floor below. Fig. 1 gives a general idea of the arrangement of a plant of this type. A series of dipping tanks is shown in Fig. 2.

The nitration operation is carried on as follows: The tank is first filled with mixed acid of the correct temperature. The cotton or shredded paper is then dumped in the acid, being quickly immersed by the rotating stirrers. The nitration is permitted to go on, generally 30 minutes, and when completed the bottom valve of the tank is opened and the acid and

cellulose nitrate fall directly into the centrifuge, where the acid is whizzed out, going by gravity to the spent acid tank. The centrifuge has a bottom discharge which permits the direct dumping of the cellulose nitrate into the first washing tank. The capacity of the dipping tanks is ordinarily about 1,600 lb. of mixed acid and the total duration of the nitration is generally 45 minutes. Using a ratio of 1 lb. of linters to 50 lb. of acid, the total production of a unit per 10 hours would be 2,560 lb. of cellulose nitrate, admitting a yield of 150 per cent. The centrifuge shown in Fig. 3 has a diameter of 42 in. and is directly driven by a 40-hp., 440-volt electric motor turning at 1,170 r.p.m. This system of nitration has many advantages over the other methods—it reduces the labor required, minimizes the production of fumes and gives a very uniform nitration—so that in the future it will be entirely used.

CENTRIFUGE METHOD

In this method, used mostly abroad, the nitration is made directly in a centrifuge with a basket specially constructed to keep the mixed acid away from the bearing of the machine. The basket can be rotated at two different speeds and can be emptied of the spent acids by a cock placed on the side of the casing. The principle of this method of nitration is based on the fact that if the basket of the centrifuge is made to rotate at a low speed (30 r.p.m.), the acid will be kept constantly in motion and will thus give a better nitration.

When the nitration is completed—that is, after 25 to 35 minutes—the acid-draining valve is opened and the high speed (1,000 r.p.m.) is put on, so as to remove as much as possible of the spent acid. This centrifuge, in which the temperature of the acid can be controlled (as the casing of the basket is jacketed), has a maximum production of 300 to 450 lb. of cellulose nitrate per 10 hours, admitting an average yield of 150 per cent, varying with the capacity of the basket. This method of nitration, which presents certain ad-

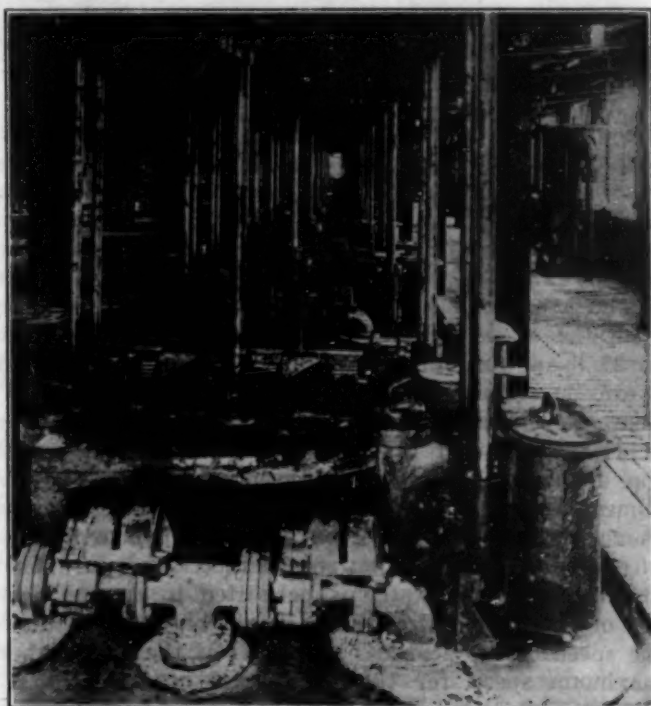


FIG. 2. MECHANICAL DIPPING TANKS FOR NITRATION

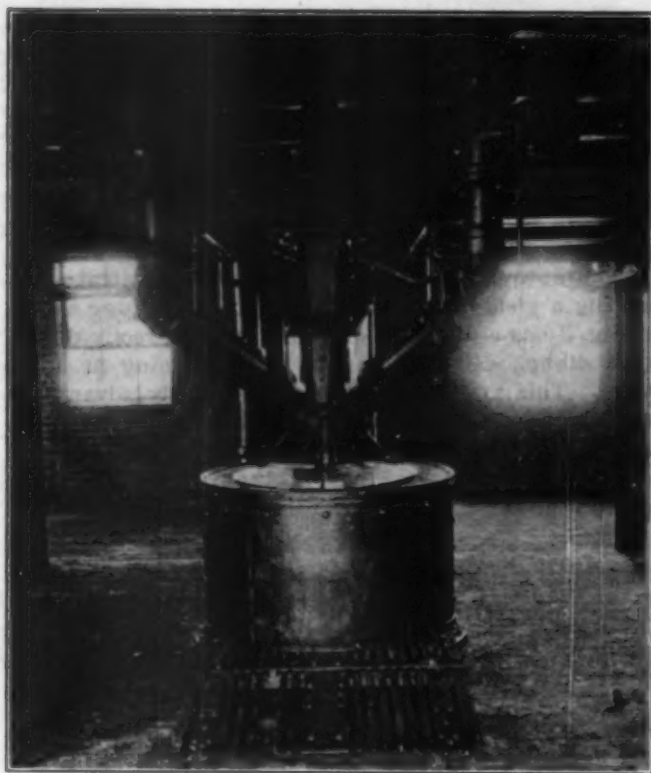


FIG. 3. CENTRIFUGE FOR CELLULOSE NITRATE

vantages, has not met with much success, on account of the cost of the installation, which is great when large quantities of cellulose nitrate are required.

DISPLACEMENT PROCESS

The displacement or Thomson process is based on the fact that if water is carefully run on the top of mixed acid in which cotton is nitrated and the acid drained out slowly, the water will displace the acid from the cellulose nitrate, not causing mixing of water and acid, which would liberate heat and thus cause decomposition of the cellulose nitrate.

The apparatus used is composed of four low cylindrical earthenware vessels, forming one unit; the conical bottom of each vessel supports a removable perforated bottom plate and terminates at the lower end in a cock for draining the acid. Fitting the top of the cylinder is a perforated plate, and on the side of the apparatus are two pipes supplying the acids and the water. A hood carried on a rail collects the fumes during the dipping of the linters, the fumes being sent outside by a fan. The process of nitration is as follows:

The hood is placed above the vessel which is filled with the mixed acid (700 to 800 lb.) and from 20 to 22 lb. of dry linters is dipped in the acids. This operation completed, the perforated top plate is placed above the linters so as to keep them immersed in the acid; then about 1 in. of water is slowly run on the top of the plate so as to prevent the formation of fumes. The hood is carried off and the nitration is then permitted to proceed from $\frac{1}{2}$ to 1 hour. The nitration completed, the bottom drain cock is opened and at the same time water is permitted to run on the top of the plate. Great care should be taken so that the speed of the acid and the water is the same; the maximum speed for the withdrawal of the acid is around 17 lb. per minute.

The acids up to a density of 1.65 are kept in a special

tank and considered as true spent acids which will be fortified with strong mixed acids to be used again in subsequent nitrations. The weaker acids are sent back to the acid manufacturer, keeping in mind that acids that are too weak will attack the iron containers. The total duration of the operation is $2\frac{1}{2}$ hours, this corresponding to a production of about 500 lb. of cellulose nitrate per unit in a 10-hour shift.

This process has many advantages, which stated briefly are: Reducing to a minimum the production of troublesome fumes; lowering the amount of acid consumed; eliminating the use of a centrifuge; reducing the time of washing and consequently the quantity of water used, etc. However, few celluloid factories have adopted this process, as it is practical only when linters are used.

WASHING

As soon as the nitration is completed, the cellulose nitrate is dumped into a tank containing a large quantity of water, where the mass is vigorously agitated by hand or mechanically, so as to reduce to a minimum the heating which will result from the contact of water with the acid. From this first washing tank the cellulose nitrate is sent ordinarily by gravity to the washing tank proper, situated on the floor below. If the prewashing is not properly made, decomposition of the cellulose nitrate will take place, a fact too often observed.

The real washing of the cellulose nitrate made with tissue paper is done in wooden tanks of rectangular or elliptical shape, which are generally covered with perforated aluminum sheets and in which a hollow drum supporting aluminum paddles is rotated, assuring the constant motion of the cellulose nitrate in the water. By changing the water frequently, the cellulose nitrate is washed until nearly neutral.

The time of washing varies with the retention of acid by the cellulose nitrate, but from seven to ten changes of water are required, the machine being kept in motion for 30 minutes between changes.

PULPING

After the cellulose nitrate has been washed, it is pulped in beating machines in the same manner that cellulose is converted into paper pulp. However, the

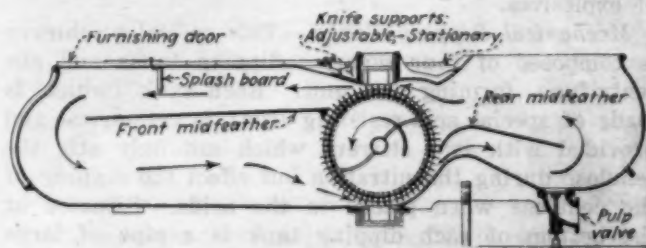


FIG. 4. DUPLEX BEATER FOR PULPING CELLULOSE NITRATE

ordinary type of beater is generally replaced by the Duplex beater, which, as will be seen from Fig. 4, has two sets of stationary knives, thereby doubling the production of the machine.

Although pulping permits better bleaching and the production of a more stable cellulose nitrate, it is not always practiced in factories using tissue paper, as the loss during the operation is great if the installation is not right. Nevertheless it would seem that this

operation is indispensable for the production of a first-class cellulose nitrate and that the loss of flock might be minimized by installing save-alls of the right kind.

BLEACHING

The bleaching of the cellulose nitrate is very important for the production of transparent and ivory plastics, and each factory has adopted formulas which vary with the grade of cellulose employed. The two methods generally employed use potassium permanganate and chlorine, respectively.

When employing potassium permanganate, a solution of 2 per cent of the weight of the cellulose nitrate is used and the water is made slightly acid with sulphuric acid. As soon as the reduction of the potassium permanganate is complete, which takes from 1 to 2 hours, the cellulose nitrate is washed and the brown color is removed by oxalic acid or, better, SO_2 .

In the second method, chlorine is employed, using solutions of bleaching powder or liquefied chlorine generally of 1 per cent strength. The time of bleaching varies from $\frac{1}{2}$ to 1 hour. Great precautions have to be taken to remove all trace of chlorine, and sometimes sodium thiosulphate or, better, sodium sulphite is used as an anti-chlor, since chlorine present in the cellulose nitrate will rapidly cause decomposition.

After bleaching, the cellulose nitrate is given from seven to ten washings with hot water and, during the first three, a solution of sodium carbonate is added so as to neutralize exactly the acidity of the cellulose nitrate. Great care must be taken to remove all traces of alkali, which, if left in the cellulose nitrate, will have a tendency to provoke discoloration of the finished celluloid. At this stage the nitrated cellulose is ready to be dried, and before this operation the finished product is whizzed so as to reduce the water content to about 35 per cent.

PURIFICATION OF CELLULOSE NITRATE FROM LINTERS

The purification process as given above is what is generally followed for cellulose nitrate made with tissue paper, but when linters are used, the treatment has to be made very carefully so as to obtain a stable finished cellulose nitrate. Generally the prewashing is followed by boiling the cellulose nitrate in circular boiling tubs with slightly acidified water, the operation lasting generally 4 hours. After boiling, the cellulose nitrate is pulped and sent to the poaching tanks (Fig. 5), where the bleaching and finishing of the purification are accomplished.

For the washing and purification only filtered and treated water can be used, and many factories have trouble in obtaining or keeping the water up to standard.

DRYING THE CELLULOSE NITRATE

The drying of the cellulose nitrate can be done by the following methods: 1. By pressing. 2. By pressing and heating. 3. By centrifuging with alcohol. 4. By alcohol displacement. 5. By alcohol and pressure.

Drying by Pressing.—The pulped cellulose nitrate after whizzing is first pressed in slabs 20 x 20 in. and of average thickness of $\frac{3}{4}$ in., between heavy cotton sheets in which the slabs are wrapped. The special hydraulic press used develops a pressure of 3,000 to 3,500 lb. per sq.in., and when enough slabs are made they are piled and placed in another hydraulic press working with the same pressure. When most of the water is thus extracted, the pressure is cut

off and the wet wrappers are replaced by dry ones and the slabs again submitted to pressure; after repeated pressing, generally twelve to fifteen times, the cellulose nitrate is considered dry—that is, it has a water content varying from 1 to 1½ per cent. This method, in which only the cotton wrappers are dried by heat, is used mostly in Europe, where labor is cheaper.

Drying by Pressing and Heating.—In this process the wet cellulose nitrate is first mixed with camphor and generally run through a rotary cutter to obtain a perfect mixture, and slabs are made as previously explained. The slabs are pressed so as to reduce their water content, then are taken out of the wrappers and transported to drying rooms, where the temperature is continuously kept at 37 deg. C. by means of hot air circulation. From 18 to 24 hours is required to dry the cellulose nitrate. This method, employed here and abroad, gives a finished product with a variable moisture content, is wasteful of camphor, and tends to develop acidity due to the prolonged heating.

Drying by Centrifuging With Alcohol.—This process of drying, mostly used in Europe, requires the use of a special centrifuge in which the basket has two perforated walls leaving an annular space in which the pulped cellulose nitrate is packed. The machine can be made to run at low or high speed and the alcohol is admitted by a perforated pipe placed in the center



FIG. 5. POACHERS FOR CELLULOSE NITRATE FROM LINTERS

and held in place by the cover of the centrifuge, which can be made air tight. After the moist pulped cellulose nitrate has been packed in the basket and the cover put in place, the high speed is shifted on so as to remove most of the water; this done, the machine is made to run at the low speed, and a known quantity of weak alcohol from a preceding operation is sent through the feed pipe; this alcohol displaces the water. This partial drying is followed by the use of 90 per cent denatured alcohol, which completes the drying process. Finally the high speed is put on so as to reduce the alcohol content of the cellulose nitrate as much as possible. The total operation takes about 1 hour, including the filling and the emptying of the machine, or a daily production of about 2,000 lb. of cellulose nitrate with an alcohol content of about 35 per cent. The alcohol required to obtain thorough drying is around 3 lb. per pound of cellulose nitrate.

Drying by Alcohol Displacement.—In this method of drying the moist pulped cellulose nitrate is placed in cylindrical tanks having conical bottoms, supporting

a perforated plate. The tanks, generally six in number, are placed in a circle, in the center of which is the centrifuge. A tank containing 90 per cent denatured alcohol is placed overhead and other tanks situated on a floor below collect the diluted alcohols which are forced on the cellulose nitrate by compressed air. This process works as follows: The cylindrical tanks are filled with the wet cellulose nitrate and in the first 90 per cent denatured alcohol is admitted. When the cellulose nitrate is completely covered with alcohol, the valve situated at the bottom of the tank is opened and the alcohol drained and collected and sent to the second tank. The first tank is then filled again with strong alcohol, and the alcohol drained from the second tank is sent to the third tank, from which it is sent to the tank containing the weak alcohol to be distilled. The alcohol collected from the second run in tank 2 is then sent to tank 3 and strong alcohol sent to tank 1. At this stage we have the first tank containing strong alcohol and cellulose nitrate free from water. The second tank contains medium strength alcohol and needs one more treatment with strong alcohol. The third tank contains only weak alcohol and will require two more treatments with medium and 90 per cent alcohol to be dried. As soon as the cellulose nitrate is dried—that is, after three treatments—it is dumped into the centrifuge so as to remove as much as possible of the alcohol. This method, in which loss of alcohol by evaporation is to be expected, requires about 2 lb. of 90 per cent alcohol to 1 lb. of pyro.

Drying by Alcohol and Pressing.—This is the dehydration process used by smokeless powder manufacturers. The wet cellulose nitrate is placed in a specially constructed hydraulic press having two pistons moving in opposite directions, the bottom one supporting a heavy perforated plate. The pistons fit exactly the cylinder of the press and a pipe placed at the top of the cylinder brings the alcohol. The bottom of the cylinder is first closed with the bottom ram and the wet pulped cellulose nitrate is placed in the cylinder and covered with a bronze plate. By means of the top piston a pressure of 3,000 lb. per sq.in. is exerted on the cellulose nitrate, forcing the water to run out through the bottom perforated plate. The top piston is then raised and denatured alcohol at 90 per cent is admitted on the top of the cellulose nitrate and sent through the cake under a pressure of 250 lb., which is then followed by a pressure of 3,000 lb. so as to expel most of the alcohol from the cellulose nitrate. The alcohol content of the dehydrated cellulose nitrate varies from 25 to 28 per cent, the strength varying from 87 to 89 per cent. The quantity of alcohol necessary for the dehydration varies from $\frac{1}{2}$ to 1 lb. per pound of cellulose nitrate treated. The diluted alcohol is collected in tanks and submitted to distillation. About 1 per cent of the cellulose nitrate is dissolved in the alcohol during the dehydration, but the loss consists chiefly of lower cellulose nitrates, the removal of which gives a cellulose nitrate of better stability.

When the cellulose nitrate is dried, it is ready to be mixed with camphor and alcohol and transformed in pyroxylin plastics.

For the illustrations accompanying this article, the author is indebted to the Charleston Industrial Corporation and the Downington Manufacturing Co.

A subsequent paper will deal with the manufacture of pyroxylin plastics.

Annual Report, Bureau of Mines

A brief summary of some of the investigations conducted by the Bureau of Mines during 1921 is given in the following paragraphs, which are based upon the annual report of the director.

An investigation of losses of crude oil through evaporation in storage and in transportation, conducted during the year by the bureau, disclosed losses of startling magnitude. It was found that in the few days in which crude oil is stored on the lease before being taken by the pipeline, the aggregate loss per year from evaporation amounts to about 122,000,000 gal. of gasoline in the mid-continent field alone. This has a value, at 22c. per gal., of \$26,840,000, and represents about 3 per cent of the total gasoline produced in the United States from all fields and all sources. A large percentage of this loss could be prevented by the use of efficient equipment.

The bureau has pointed out the considerable losses which have resulted from the failure of many refineries to recover gasoline from uncondensed still vapors. The significance of this investigation is shown by the fact that one refinery in the mid-continent field is now recovering from still vapors approximately 400 bbl. of gasoline daily which before the installation of this equipment was either lost or burned as fuel under the boilers and stills. The value of fractionating towers at petroleum refineries, by means of which some companies have increased the yield of gasoline from crude oil by as much as 5 per cent, or 16 $\frac{1}{2}$ per cent of the total gasoline yield, has been demonstrated. A special process, devised at the San Francisco station of the bureau, for cracking heavy oils and tars promises the recovery of large yields of gasoline and other lighter products, hitherto regarded as unrecoverable.

PRODUCTION OF HELIUM

The experimental helium plant at Petrolia, Tex., conducted under the authority of the Army and Navy Helium Board, was in operation during the year at various times, and helium was produced for short periods. A study of the practicability of storing this rare and non-flammable gas in mine workings was made at the bureau's experimental coal mine at Bruceton, Pa. At the cryogenic laboratory in Washington, D. C., liquid air in quantity is now being produced. The primary object of this laboratory is to investigate gases and liquids at low temperatures, with special reference to the separation of helium from natural gas.

MOLYBDENUM AND ZINC

The bureau investigated the properties and possibilities of molybdenum, of which the United States possesses the largest known deposits.

The cost of production of zinc, with the standard retort process, is now so high that it endangers the position of zinc as a cheap metal. Plans have been formulated for an investigation of proposed methods for the electrothermic metallurgy of zinc, with a view to increasing the recovery of metal and lowering production costs.

Methods for preparing caustic magnesia were investigated which determined that high-grade magnesia can be made from some varieties of magnesite hitherto believed to be unsuitable for this purpose. The bureau investigated dolomite as a substitute for the more costly magnesite in preparing refractories, and demonstrated that there can be obtained from Ohio dolomite a product superior in magnesia content to Canadian magnesite.

Deoxidation and Desulphurization in the Heroult Furnace

Three Methods of Working Up a Heat of Steel Are Described in Detail—Composition and Characteristics of Slags Are Noted, and the Opinion Is Expressed That Good Steel From Poor Scrap Is Merely a Question of Knowledge and Skill

By F. T. SISCO
Metallurgist

FOUR characteristics and advantages of electric steel are, in the order of their importance from the standpoint of an electric steel salesman:

- (1) It is made to close chemical specifications.
- (2) Free from excessive segregation.
- (3) Free from more than traces of sulphur and phosphorus.
- (4) A thoroughly sound and deoxidized product may be made.

Furnace practice as developed in the past few years has made the first advantage a certainty. Practically all electric steel is now being made in any desired analysis and to any tolerance in the specifications. The second item—freedom from excessive segregation—is a matter of mold design, use of proper sink-heads, correct pouring temperature and sufficient cropping. This question will not be discussed here.

By most manufacturers the third characteristic is met to a surprising degree, much of the electric steel now being turned out containing less than 0.02 per cent of both these elements. In fact, it is altogether probable that too much attention is being paid to the reduction of the phosphorus and sulphur, particularly the latter, sacrificing complete deoxidation and thorough soundness.

After close observation of Heroult furnace practice in four plants and covering a period of 8 years, the author has concluded that much is yet to be desired as far as quality in electric steel is concerned. Electric steel from the Heroult furnace may and does surpass the best basic open-hearth and even the best acid open-hearth steel in quality, but with few exceptions is still decidedly inferior to crucible steel. This inferiority is partly caused by insufficient knowledge of the proper conditions for deoxidizing the metal, and partly to the wrong assumption on the part of the electric furnace melter that the function of his final slag is primarily to desulphurize. As a result, he makes his slag with that in mind, removes all of the sulphur possible and depends upon ferromanganese, ferrosilicon and occasionally aluminum, added in the last 15 or 20 minutes, to accomplish his deoxidation. This dependence upon a ferro-alloy to deoxidize a bath of molten electric steel is putting the process in a class where it approaches open-hearth practice and is bound to produce a product that in some cases is little better than good open-hearth steel.

The great advantage of the electric furnace is the flexibility and accuracy of control of the heat, permitting any slag or an oxidizing, a reducing or even a neutral atmosphere. Not to take advantage of the reducing conditions possible to form a slag so reducing in character that deoxidation will be nearly complete without the aid of a ferro-alloy is to neglect one of the most salient features of the electric furnace.

The superiority of crucible steel is due to the perfect deoxidizing conditions obtained by melting muck bar or any first-class scrap in an atmosphere entirely free from oxygen, the melted charge being permitted to lie quietly until solid and gaseous inclusions present in the base used have time to rise to the top. This cleaning action is aided to a slight extent by the presence of one or more ferro-alloys melted with the scrap, which have in themselves a strong affinity for oxygen. To make a product equal to crucible steel, the electric furnace must duplicate these melting conditions as nearly as possible. Not only that, but the electric furnace, to be a commercial success, must produce a product equal to crucible steel from a cheaper base.

The metal ready for the deoxidizing slag (or white slag as it is commonly called), whether melted under oxidizing conditions in the electric furnace itself, as is the case with units of 8 tons or less, or delivered molten from an open hearth, as in the larger furnaces, is generally low in carbon, almost free from silicon, phosphorus and manganese and nearly saturated with both oxides and gases. It is the function of the white slag to aid in the complete removal of these oxides and gases, whether present in large or small amounts. Incidentally the slag also removes the sulphur more or less completely.

The amount of oxides and gases present in the molten bath depends wholly upon the melting practice; three general classes are: (1) Melting without oxidation. (2) Melting with partial oxidation. (3) Melting with complete oxidation.

Melting Without Oxidation.—This practice is confined almost wholly to melting for high-grade tool steels and ball-bearing steels where the base material is very pure. For making high-grade carbon tool steels a base of muck bar and washed metal is melted down either alone or combined with a varying amount of rolling mill crop ends in which the sulphur and phosphorus are both under 0.02 per cent. In charging the raw material, a small amount of limestone is placed on the bottom of the furnace and building the white slag commences as soon as there is a pool of molten metal around the electrodes. With this practice oxidation may be almost wholly prevented, the only function of the white slag being to aid in the removal of such oxides as are present in the raw material charged. This practice results in a steel which may easily be made the equal of the best carbon tool steel made by the crucible process and is duplicated on alloy steels by using a charge made up wholly of butts, crop ends and discards from their own mills. Needless to say, this practice produces the best electric steel, but is not able to compete in price with steel made from a cheap scrap or molten open-hearth metal.

The important feature of melting under a white slag is the use of a charge that is within the specified

26 124
103 64
100 4

TABLE I. MELTING WITH PARTIAL OXIDATION

Furnace No. A. Heat No. 1687		Analysis Desired 1.00/1.15 0.15/0.25 0.02 0.02 0.25/0.45 1.35/1.65																		
Time		Lb.	Metal Tests						Slag Tests											
			C	Si	S	P	Mn	Cr	SiO ₂	FeO	Al ₂ O ₃	MnO	CaO	MgO	CaS	CaC ₂	Cr ₂ O ₃	P		
2:05 p.m.	Previous heat tapped.....																			
2:20 p.m.	Began charging, limestone.....	750																		
	Scrap, chromium butts.....	6,530	1.05	0.20	0.020	0.020	0.35	1.45												
	Mixed bearing scrap.....	2,610	1.00	0.20	0.030	0.025	0.35	1.10												
	Mixed low-phos. scrap.....	5,960	0.40	.....	0.040	0.040													
			About																	
2:55 p.m.	All scrap charged.....	15,100	0.80	0.15	0.030	0.030	0.35	0.75												
3:00 p.m.	Power on.....																			
5:40 p.m.	Melted, fluorspar added.....	35	0.62	0.03	0.026	0.013	0.25	0.42	9.37	9.25	2.78	2.76	51.15	12.47	0.026		9.32	0.63		
5:55 p.m.	Oxidizing slag off.....																			
6:00 p.m.	White slag added, lime.....	650																		
	Coke.....	200																		
	Spar.....	150																		
6:25 p.m.	Slag partly white.....		0.65	0.036	0.025	0.014	0.25	0.43	8.73	3.42	2.97	0.25	63.87	11.17	1.62		0.63	0.026		
6:35 p.m.	Slag all white, partly carbide.....		0.67	0.031	0.017	0.014	0.26	0.44	10.27	1.38	2.55	0.13	64.27	10.26	1.98	1.70	0.25	0.008		
6:40 p.m.	Ferromanganese, 80 per cent, added.....	23																		
6:45 p.m.	Slag strongly carbide.....		0.68	0.031	0.015	0.014	0.37	0.44	9.26	0.97	3.24	0.19	65.87	10.47	2.13	2.87	0.06	0.004		
6:50 p.m.	Ferrosilicon, 64 per cent Cr, 6 per cent C.....	260																		
7:00 p.m.	4 Shovelsful mixed slag added.....																			
7:15 p.m.	Bath stirred, slag strongly carbide.....		0.78	0.057	0.014	0.015	0.38	1.49	13.42	0.87	2.65	0.17	63.06	9.65	2.07	2.65	0.37	0.006		
7:20 p.m.	7 Shovelsful mixed slag added.....																			
	Washed metal added.....	850																		
7:35 p.m.	Added ferrosilicon, 50 per cent.....	65																		
7:45 p.m.	Heat test quiet, slag carbide.....		1.02	0.210	0.013	0.016	0.37	1.47	9.73	0.65	2.28	0.09	66.45	10.28	2.23	3.67	0.04	None		
7:50 p.m.	Heat tapped.....																			
	Ladle.....		1.04	0.206	0.012	0.017	0.36	1.48	10.03	0.72	2.78	0.11	65.63	10.03	2.11	3.43	0.05	Trace		

Note: Furnace doors open more than in regular practice due to taking extra slag and metal tests.

limits in phosphorus, as none is removed in melting, and of material as free as possible from rust and scale.

Melting With Partial Oxidation.—This method is undoubtedly the best where a cheaper base is used and where fairly high-carbon steel is made. The practice consists essentially of charging limestone on the bottom of the furnace and then loading in the scrap. This consists of ordinary low-phosphorus material (0.04 per cent) such as crop ends, boiler plate and (if alloy steel is to be made) nickel or chromium-nickel scrap from automobile plants or rolling mills, or forging billet and bar crops. A clean scrap free from rust and scale is used and the charge regulated as much as possible so the carbon when melted will be 0.10 to 0.30 per cent below the requirement. The charge is melted cold and the slag which has formed is removed as soon as the charge is all melted. The resulting bath contains most of the oxidizable elements except silicon and phosphorus, which latter has been reduced by the very basic slag from about 0.04 per cent to below 0.02 per cent. Since the

molten charge contains most of the carbon and manganese, the absence of more than small amounts of oxides is assured. The remainder is then eliminated by aid of the white slag which is immediately built up as soon as the first slag is removed. Table I gives a furnace log of a heat melted in this manner.

MELTING WITH COMPLETE OXIDATION

This practice, the most common, has the advantage that the scrap is freed except for traces of all oxidizable elements—carbon, silicon, phosphorus and manganese. A portion of the sulphur is likewise eliminated down to the point shown in Table II. Complete oxidation is necessary when a low-carbon product is desired, and this process permits of the use of a very cheap grade of scrap, phosphorus as high as 0.08 to 0.10 per cent being reduced with ease to below 0.02 per cent. To facilitate the active oxidation which takes place, limestone is charged on the bottom of the furnace. Iron ore or roll scale, to furnish the oxygen, follows. If much fine scrap

TABLE II. MELTING FOR COMPLETE OXIDATION

Furnace No. B. Heat No. 1276.			Analysis Desired 0.60/0.70 0.15/0.25 0.02 0.02 0.25/0.45														
Time		Lb.	Metal Tests					Slag Tests									
			C	Si	S	P	Mn	SiO ₂	FeO	Al ₂ O ₃	MnO	CaO	MgO	CaS	CaC ₂	P	
7:35 a.m.	Previous heat tapped.....																
7:55 a.m.	Began charging { Limestone.....	600															
	Roll scale.....	50															
	Scrap, country mixed.....	7,550			0.06	0.10											
	Shell scrap, (1 lb.).....	3,070			0.045	0.035											
	Crop ends, carbon.....	2,530	1.00	0.25	0.020	0.020	0.25										
	Hay.....	1,720			high	high											
8:35 a.m.	All scrap charged.....	14,870	0.60	0.08	About 0.055	0.070	0.35										
8:40 a.m.	Power on.....																
11:05 a.m.	All melted, roll scale added.....	50	0.08	0.01	0.046	0.013	Trace	20.37	17.78	3.25	7.68	41.45	7.13	0.037			P ₂ O ₅ 2.37
11:25 a.m.	Oxidizing slag off { Recarburized.....	80															
	Electrodes.....																
11:30 a.m.	Bath wild, added crushed ferrosilicon.....	13															
11:45 a.m.	White slag on, lime.....	600															
	Coke.....	175															
	Spar.....	150															
12:15 p.m.	Slag partly white.....		0.52	0.024	0.037	0.014	Trace	8.75	4.78	2.26	Trace	66.27	10.42	1.93	0.48	0.013	
12:30 p.m.	Slag all white.....		0.53	0.025	0.028	0.014	Trace	10.32	1.87	1.89	Trace	65.43	9.37	2.18	1.51	0.006	
12:35 p.m.	Added ferromanganese, 70 per cent.....	70															
1:00 p.m.	Slag strongly carbide.....		0.57	0.032	0.019	0.014	0.36	10.87	1.02	2.07	0.37	67.38	7.46	2.59	2.78	Trace	
1:05 p.m.	Added 5 shovelsful mixed slag.....																
1:30 p.m.	Slag strongly carbide.....		0.58	0.030	0.018	0.015	0.36	12.65	0.96	3.25	0.27	65.82	8.17	2.67	2.45	None	
1:45 p.m.	Added ferromanganese, 70 per cent.....	5															
1:50 p.m.	Added ferrosilicon, 50 per cent.....	70															
2:00 p.m.	Heat test quiet, slag carbide.....		0.60	0.186	0.016	0.015	0.38	14.03	0.90	2.96	0.17	63.71	9.65	2.85	2.86	None	
2:05 p.m.	Heat tapped.....																
	Ladle.....		0.64	0.197	0.014	0.016	0.38	14.27	0.84	2.73	0.13	64.87	10.29	2.79	2.16	Trace	

Note: Furnace doors open more than in regular practice due to taking extra slag and metal tests.

such as clippings or punchings are used, or if the scrap is rusted, the amount of ore or scale may be reduced. In the case of very rusty scrap, no ore is necessary. The charge is melted at a high temperature, oxidation being nearly always complete by the time the metal is melted. When very high-phosphorus scrap is used, more ore is often added as soon as the bath is nearly melted. This oxidizing slag, corresponding in analysis to the first slag in Table II, is removed entirely. If medium- or high-carbon steel is to be made, carbon in the form of crushed coke or electrodes is added to the bare metal to bring the carbon up to within 0.10 to 0.20 per cent of the required analysis. If the bath should then boil violently, a few shovelful of crushed ferrosilicon would be added to kill the wild metal. White slag is now added in order to deoxidize and produce a sound steel. A deoxidizing slag must do the greatest amount of work in this melting practice, since oxidation is carried to a maximum. Great skill is required in this deoxidizing practice to produce a sound steel.

This class of practice includes duplexing. Metal as received by the electric furnace from the open hearth is in a very similar condition as to chemical analysis and amount of oxides present as ordinary scrap melted in the electric furnace with complete oxidation. In duplexing open-hearth metal for the production of high-grade ordnance and armor plate, the present practice is to deoxidize partly by adding 12 per cent ferrosilicon to the open-hearth metal just before tapping. This is good practice and decreases the amount of work thrown upon the electric furnace.

In every case, whether the melted steel is not oxidized at all, partly oxidized, or wholly oxidized, the function of the deoxidizing or white slag remains the same—to aid in removing oxides and gases, to reduce those oxides which rise to the surface of the bath and to eliminate sulphur.

WHITE LIME SLAGS

There are two methods of building white slags. The first makes a white lime slag, pure white in color, which disintegrates rapidly in air to a fine white powder. It contains lime, coke and spar in the ratio of about 10 to 1 and contains about 70 to 75 per cent bases and 15 to 25 per cent acids (see Table III). As a slag it is not strongly reducing, but serves more as a covering for the metal while the bath slowly frees itself from its occluded oxides and gases. In building this slag lime is thrown onto the bare metal until it is covered. On top of this blanket of lime is scattered powdered coke. It is certain that some calcium carbide forms around the arc, which is immediately broken up by the atmospheric oxygen in the furnace as it spreads out from the electrodes, the carbon burning to carbon monoxide, CO. Fluorspar is added until the slag has the proper consistency. Some melters use silica sand and even powdered glass instead of fluorspar. Fluorspar, however, is a much better thinning agent than silica sand and has the advantage that it is a more active desulphurizer. In addition, it is undesirable to reduce the proportion of bases any more than is necessary to secure fluidity.

Deoxidation with this white lime slag is primarily a mechanical process, the small amounts of oxides and silicates in the bath slowly rising until seized by the slag and held partly in chemical combination and partly in suspension. Deoxidation, too, is never very complete with this slag. Even after the bath has been under the slag for 3 or 4 hours, metal tests show considerable

wildness. When the heat is ready to tap, deoxidation is accomplished by adding ferrosilicon with a thorough rabbling as soon as the alloy is melted. When silicon specifications are low, it is almost always necessary to rabble in aluminum to put the bath in such condition that the metal will lie quietly in the molds after pouring.

There is only one advantage in using this slag: There is no appreciable carbon absorbed from the slag. The only possible justification for the use of a white lime slag is when very low-carbon steel is desired; even then the practice should be modified somewhat by having some carbide present. The disadvantages are many:

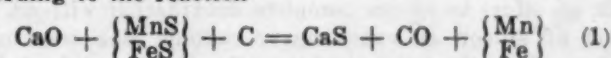
Deoxidation is too slow and too uncertain, making it necessary to add ferrosilicon or aluminum or both. While ferrosilicon or aluminum is very efficient and deoxidizes a bath completely in a few minutes, it is practically impossible for the heat to free itself from the non-metallic reaction products formed by the reaction between entrapped oxides and gases and the ferrosilicon or aluminum in the short time between the addition and tapping, causing "slag spots," which, even though they may be microscopic in size, are nevertheless sources of weakness. There is also no certainty that harmful oxides will be rendered harmless by silicon. Too often, in practice, a final heat test lies quietly, while the ingots poured are so "blowy" that they have to be scrapped. White lime slag and the more common white slag containing very small amounts of calcium carbide

TABLE III. TYPES OF ELECTRICAL FURNACE SLAGS

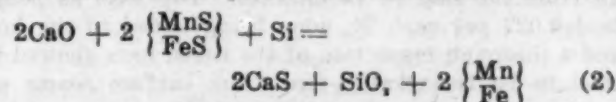
	White Lime Slag Not Reducing ₁	White Carbide Slag Very Reducing ₂
SiO ₂	17.57	7.48
FeO.....	1.33	0.35
Al ₂ O ₃	3.12	2.17
MnO.....	0.36	0.05
CaO.....	62.45	65.82
MgO.....	11.65	13.78
CaS.....	0.87	2.26
CaC ₂	None	4.54

have no redeeming features with the exception of the fact that no carbon is picked up by the metal. The practice of using these slags in conjunction with subsequent additions of deoxidizers in the form of ferroalloys cannot be too strongly condemned; a steel is produced which may be passable in some instances, but usually it will not be of a grade that brings repeat orders from the buyer.

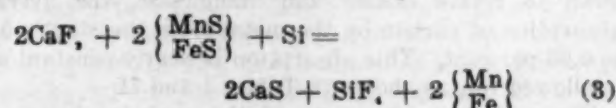
Desulphurization with a white lime slag proceeds according to the reaction



the carbon being present in small amounts from coke added to the slag and from the electrodes. It is probable that reaction (1) is aided by reaction (2) when calcium carbide is not present in considerable amounts:



through small amounts of metallic silicon either added intentionally or reduced from silica (SiO₂) by the arc. It is also aided by reaction (3):



through the combined effect of small amounts of silicon and fluorspar.

In any case, when a white lime slag is used desul-

phurization depends on basicity, temperature and the saturation point of that particular slag for calcium sulphide. It is doubtful whether high sulphur (0.06 to 0.08 per cent) could be removed without the presence of considerable amounts of calcium carbide, but a sulphur content of 0.03 or 0.04 per cent can easily be reduced to 0.02 per cent or below with the white lime slag.

WHITE CARBIDE SLAGS

The carbide slag, the most common of electric furnace finishing slags, is preferably composed of lime, coke and fluorspar in the ratio of 6 to 2 to 1, varying slightly with furnace conditions and with the steel made. The slag ingredients are mixed thoroughly on the floor before being charged. Approximately 1 lb. of slag mixture is used for 15 lb. of metal, the larger hot-metal furnaces taking less slag in proportion than the smaller furnaces working on cold scrap. Immediately after removing the oxidizing slag and any necessary recarburization the well mixed slag material is thrown on the bath. In 20 to 30 minutes, with a high temperature, a slight frothing begins around the electrodes and gradually extends to the banks. The slag is in good condition 30 to 40 minutes after being added. It is now only necessary to add lime, coke or spar in small amounts to maintain proper slag conditions until the heat is ready to tap. The gentle boiling or frothing of the bath slowly dies down; about an hour after the slag is in condition it is perfectly quiet. A metal test will show very slight bulging and practically no sparking when deoxidation is complete. Ferrosilicon is now added to give the required analysis and the heat is tapped. With a proper carbide slag, less than 10 per cent of the ferrosilicon is lost, 90 per cent or more alloying with the metal.

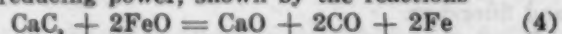
The slag when spread on a plate disintegrates slowly in the air to a grayish powder and when moistened with water smells very strongly of acetylene. As shown in Table III, it will contain from 0.5 to 2 per cent carbon, equivalent to 1.40 to 5.6 per cent calcium carbide.

A DISADVANTAGE OF THE CARBIDE SLAG

The one disadvantage of the carbide slag is the large absorption of carbon by the bath. An extreme case of this absorption was shown by an order of low-silicon steel made at an Eastern plant. Carbon was specified 0.65 or 0.75 per cent and silicon 0.08 per cent or under. In an effort to insure complete deoxidation without the aid of silicon an extra heavy carbide slag was used. Forty-five minutes before tap the bath contained 0.58 per cent carbon. No carbon was added in any form except in the slag-making materials, yet the ladle test showed 0.71 per cent carbon, 0.13 per cent being picked up from the slag in 45 minutes. The steel as poured held 0.027 per cent Si, none being added to the heat, and a thorough inspection of the rolled bars showed the steel to be remarkably free from surface seams and cracks. The slag immediately before tap contained 5.78 per cent calcium carbide.

In average practice, using fair scrap and melting down to retain carbon and manganese, the average absorption of carbon by the metal from the slag is 0.03 to 0.05 per cent. This absorption is nearly constant and is allowed for, as shown in Tables I and II.

The principal advantage of the carbide slag is its intense reducing power, shown by the reactions



These equations show the end results of some very complicated reactions. By the aid of the calcium carbide the greatest part of the deoxidation takes place during the deoxidizing period exactly when it should and not in the final 15 minutes, aided by a ferro-alloy.

By careless furnace practice the carbide slag may easily become as inefficient as the white lime slag—in fact it may easily turn into a white lime slag through neglect. Atmospheric oxygen coming into the furnace through frequent opening of furnace doors reduces the efficiency and deoxidation power of the slag to a point where it is very little if any better than the white lime slag.

A visual examination of a carbide slag will show the effect of an oxidizing atmosphere. A spoonful of slag is removed from a point midway between the electrodes and the bank, permitted to solidify in the spoon, and then knocked out and examined. On the surface exposed to the air the slag will have the pure white color of lime, while next to the metal of the spoon the dark gray of the carbide will be plainly noticeable.

DEOXIDIZING WITH AIR-TIGHT FURNACE

An extensive investigation of the plan of deoxidizing with a practically air-tight furnace was undertaken a few years ago in connection with a contract for 600 tons of ingots for 12-in. armor-piercing shells. A 6-ton Heroult furnace was used and the scrap was a mixture of nickel-steel crop ends, chromium-nickel gears and flashings, boiler plate and punchings. Oxidation was carried to completion, the oxidizing slag being removed by hand rabbling. A well-mixed carbide slag was then shoveled into the furnace, and the doors were closed and sealed with fireclay. After 30 minutes one door was opened sufficiently for additions of alloys and further slag material, and then sealed again. This practice was followed for about 100 heats. Steel was poured into regulation shell molds without sinkheads. On stripping, the surface of the ingots was in every case found to be free from pits, and the top surface showed complete absence of oxidation bubbles. A report from the forger stated that every heat forged perfectly, all shells passing inspection easily. Physical tests were in every case satisfactory and usually superior to requirements.

Every heat tapped had a slag that was intensely reducing. Although slag analyses were not made, each ladle slag after dumping into the pit and cooling with water gave an odor of acetylene that could be detected within a radius of 50 ft.

Carbon absorption was calculated at 0.06 per cent, each heat being tapped on 0.46 to 0.48 per cent to meet a specification of 0.50 to 0.60 per cent.

It is unquestionable that the exclusion of atmospheric oxygen from the furnace produces a more completely deoxidized metal and leads to better slag conditions. It is also beyond possibility of doubt that deoxidation in the furnace by aid of a slag high in calcium carbide produces a better steel more consistently than a simple treatment with a highly basic lime slag and subsequent deoxidation by a ferro-alloy before tapping.

The amount of oxides in the metal determines the amount of calcium carbide that must be maintained in the slag. By carrying a simple lime slag, a charge of muck bar and washed metal and rolling mill crop ends may be deoxidized to make a thoroughly sound steel. By having 1.0 to 2.0 per cent calcium carbide, a steel melted with partial oxidation, the carbon and manganese

remaining to a large extent in the metal, will be deoxidized satisfactorily. But a steel containing a large amount of oxides, when melted low in carbon by the use of ore or on a metal duplexed from an open-hearth furnace and not partly deoxidized in that furnace, requires a very heavy carbide slag, preferably one containing 2 to 5 per cent calcium carbide.

For general purposes when making miscellaneous alloy and tool steels from ordinary scrap, the best furnace practice for a consistently satisfactory product, is:

(1) Melt to retain part of the carbon and manganese; remove phosphorus by means of a very basic slag, omitting ore or other oxide and using clean scrap.

(2) Unless absolutely necessary do not recarburize on the bare metal after the first slag has been removed. If a small amount of carburization is necessary after all alloy additions, use clean pig iron or washed metal. In an emergency, run the electrodes down into the bath.

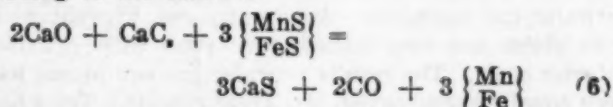
(3) Mix the deoxidizing slag materials thoroughly, using 5 or 6 parts of burnt lime, 2 parts of powdered coke and about 1 part of clean gravel fluorspar, and add 1 lb. of this mixture for 15 to 18 lb. of metal immediately after the complete removal of the first slag. When melting clean scrap the amount may be reduced to 1 lb. of slag for each 25 lb. of metal.

(4) Use high power for at least 30 minutes, until frothing of the slag is gentle and uniform over the whole bath.

(5) Exclude atmospheric oxygen as much as possible during the deoxidizing period.

(6) With these conditions present and using a scrap not exceeding 0.04 or 0.05 per cent sulphur, desulphurization will proceed automatically to a residual of 0.015 per cent or lower.

Desulphurization with a strong carbide slag proceeds according to the reaction



This reaction, too, is the result of more complicated reactions and is generally in conjunction with reaction (1). Reactions (2) and (3) likewise occur when carbide is present, but are secondary in importance to reaction (6).

Many variables influence the desulphurizing power of the carbide slag, although this slag is much more sure in its action than the white lime slag. In order to have much carbide in the slag, the temperature must be high; therefore desulphurization proceeds rapidly. Likewise the carbide slag is always extremely basic. As before stated, it has been proved by countless trials that fluorspar is a distinct aid in desulphurization and in this respect is much superior to silica sand for slag making. Carbide slag saturated with calcium sulphide runs slightly higher in S as the temperature, basicity and amount of calcium carbide increase. It has been possible at times when working with slags very high in carbide to have these hold as much as 4.50 per cent calcium sulphide; this, however, is exceptional, 3.5 per cent saturating the average slag.

A peculiarity of carbide slags that has been largely overlooked by metallurgists, is that the efficiency of the slag as a deoxidizing agent decreases rapidly as the saturation point of the slag for calcium sulphide is approached, and this point is easily approached when the lime and coke used both contain up to 1 per cent sul-

phur. For this reason low-sulphur lime and coke should be used for the slag and a scrap base containing more than 0.05 per cent sulphur should be avoided, if the steel is to be sound, both completely deoxidized and desulphurized.

As one-tenth of the sulphur, sometimes even more, is removed in melting and oxidizing (see Table II), the deoxidizing slag must remove about 0.03 per cent—more than half the original sulphur. This can be done easily with a fairly pure slag, without impairing its efficiency as a deoxidizer.

A peculiar feature, at present not well understood, is the decreased power of a strong carbide slag for removing sulphur when the furnace is kept nearly air tight. In the 600-ton order above mentioned, in which a thoroughly sound and nearly perfectly deoxidized product was attained, in every case without exception the carbide slag removed less than one-third the sulphur, whereas in average practice with no precautions to exclude atmospheric oxygen from the furnace (Table II) sulphur losses amount to 70 per cent and often reach 80 per cent. The scrap charged for the shell steel contained an average of 0.03 to 0.04 per cent sulphur; allowing 10 per cent of this to be removed in the oxidizing period, it is readily seen that the carbide slag absorbed very little, since the analysis of the 100 heats showed sulphur contents of 0.023 to 0.031 per cent.

It may be conceded that steel containing 0.03 per cent sulphur is exactly as good as if the sulphur content were 0.015 per cent. The amount of manganese sulphide present with the higher sulphur is so small and in good steel is so well distributed that possibility of harm from this source is nil. Far more harm and injury may be done by attempting to reduce the sulphur to 0.015 per cent at a sacrifice of complete deoxidation.

DESULPHURIZATION VS. DEOXIDATION

Three things are possible in the deoxidizing period in the Heroult furnace: (1) Desulphurization without thorough deoxidation. (2) Thorough deoxidation with little desulphurization. (3) Thorough deoxidation with complete desulphurization.

The first condition exists when a very basic lime slag containing no calcium carbide is used; the resulting steel is not good, even if the sulphur is reduced to a trace. Practically all of the deoxidation must be carried out by means of ferro-alloys added at the end of the heat.

The second condition prevails when a very basic slag containing considerable calcium carbide is used in an air-tight furnace; an exceptionally sound steel is regularly and consistently obtained, a steel free from blowholes and slag inclusions but only a small percentage of the sulphur has been removed. This practice is to be recommended, however, in preference to the first.

The third condition is difficult to realize in practice; yes, doubly difficult, since the average melter has been educated to believe that deoxidation is secondary in importance to desulphurization, the very opposite to the truth. This third condition is met partly by a strongly reducing carbide slag and by keeping the slag strongly reducing by further additions of lime and coke from time to time. While the doors are not sealed tight, they are kept closed as much as possible so that the carbide present will not be oxidized much by the air. Table II gives the complete history of a heat of carbon

chisel steel made from a poor grade of scrap and oxidized completely, the bath recarburized and deoxidized by means of an average carbide slag. The heat represents ordinary practice and is neither very good nor very bad. The heat was poured into 9 x 9-in. ingots, the ingots were chipped, reheated and roughed to 2½-in. square billets. The billets were chipped but not pickled. Finished rolling was into mill length ¼, ⅓ and 1 in. octagon. Approximately 15 per cent of the finished bars were scrapped on account of seams.

In contrast to this, Table I shows the history of a heat of first-class ball steel. This heat was also poured into 9 x 9-in. ingots. The ingots were chipped, reheated and roughed to 4½-in. gothics. The top and bottom discard was nicked by the hot saw and fractured. The gothic billets were pickled and chipped, very little chipping being necessary, and were finished to 2-in. and 2½-in. rounds, mill lengths. Less than 5 per cent of the heat was rejected for surface defects on inspection.

GOOD STEEL REQUIRES THOROUGH DEOXIDATION

The author has seen 40-ton heats of chromium-nickel steel for navy guns, after 4 hours' electric refining, that were chemically, physically and microscopically the finest steel possible to make by any process. On the other hand, he has watched a melter throw shot aluminum by the shovelful into the ladle of a 20-ton electric furnace heat to quiet it enough to pour. He has seen 6-ton heats, made from the best-selected open-hearth and electric furnace scrap, that would scarcely stay in the molds and the cross-section of the ingots resembled a piece of Swiss cheese. On the other hand, he has seen 6-ton heats case-hardening gear steel of an analysis 0.08 to 16 per cent carbon, 3.50 per cent nickel and 2.00 per cent chromium, that rolled into a 100 per cent perfect product.

Whether duplex is better than cold-scrap electric steel has been argued pro and con for the past 10 years, the controversy waxing hottest during the war. It may be said once and for all that the quality of electric steel does not depend upon the base used; good scrap, bad scrap, molten open-hearth metal, molten bessemer metal, whether melted in 1-ton or 40-ton lots may all be refined and deoxidized completely and thoroughly with the proper slag made under the proper conditions and handled by men who know how. Naturally, the more nearly the steel is deoxidized before the final electric furnace slag is applied the easier deoxidation will be, but the complete deoxidation in any case is merely a matter of correct slag conditions for the proper time.

Charleston, W. Va.

Italy Considering Limitations on the Exportation of Metals and Waste Metals

The recent decree providing that the customs officials at Italian frontiers and seaports may permit the exportation of lead, copper, manganese and zinc metals, lead residues, ashes of iron pyrites, waste copper, tin, zinc, brass, bronze, aluminum and nickel is not working satisfactorily, reports the special correspondent of CHEMICAL & METALLURGICAL ENGINEERING. It has led to the exportation of large quantities of these products to Germany, Czechoslovakia, Austria and other countries, to the deprivation of home producers. Accordingly a petition has been presented to the Minister of Industries, setting forth the damage already suffered and likely to be suffered later and asking that the decree be abrogated for the present.

Oil and Coal as Plastic Fuels

A new combination of oil and coal in a plastic fuel which suggests large possibilities was recently described* by Walter E. Trent of Washington, D. C. This was the first public discussion by Mr. Trent of the process on which he has been working for several years and on which the Bureau of Mines has been co-operating for some time past. He described further the commercial possibilities of the process, some features of which were given in CHEMICAL & METALLURGICAL ENGINEERING of Aug. 3, 1921, p. 182.

That coal, oil and water can be premixed in just the right proportions for water-gas manufacture and can be simultaneously introduced into the generator in intimate contact with one another is one of the most interesting possibilities suggested by Mr. Trent's work. The process is based upon the reaction by the coal and oil which follows mixing oil with a suspension of very finely ground coal in water. The coal is ground wet and to the suspension oil is added equal to about 30 to 40 per cent of the weight of the carbonaceous matter present. The oil and coal agglomerate into a plastic mass which is very easily separated from the water and ash.

COMMERCIAL SCALE PLANT IN OPERATION

Mr. Trent has built a commercial-scale plant at the former yards of the Virginia Shipbuilding Corporation, Alexandria, Va., where the layout contemplates a completed plant to handle 1,000 tons per day of raw coal. At present the first of four units having a daily capacity of about 250 tons is the only one complete. Mr. Trent is operating this plant regularly on a variety of coals, including many experimental tests of 50-ton and larger lots to determine the suitability for use with his process.

A number of experiments have been made on production of city gas from the amalgam both by distilling this in ordinary coal-gas retorts and by treatment of it in water-gas machines. Apparently gas, byproduct and coke yields are very satisfactory even with relatively inferior coals. The results in water-gas equipment have been equally encouraging, Mr. Trent reports. Tests have also been conducted on a limited scale as to the application of the amalgam for manufacture of producer gas. Mr. Trent states that by this means very good yields of a producer gas approximating 400 B.t.u. per cu.ft. will probably be obtainable.

The plastic material can be burned on certain types of stoking and boiler equipment, and further tests along these particular lines are now under way. Considerable use of the material as a domestic fuel is also being practiced locally in Alexandria, but Mr. Trent points out that the fuel, though otherwise very satisfactory, is certainly exceedingly dirty for domestic use and on this score quite objectionable in many circumstances.

Mr. Trent contemplates experimentation on the low-temperature distillation of the amalgam by special methods now under development. By this means he hopes to recover not only the original oils used but also the byproducts from the coal and to make smokeless fuels in the form of almost ashless briquets. This has been done on a small scale, but the large-scale work is not yet under way. The Bureau of Mines has made a study of certain of the fundamentals involved in the distillation of these amalgams.¹

*Before the Washington Section, A.S.M.E., Nov. 22, 1921.

¹See Davis, Place and Scott, "Destructive Distillation of Mixtures of Oil and Coal," CHEM. & MET. ENG., vol. 25, No. 25, p. 1131, Dec. 21, 1921.

Low-Temperature Carbonization in England

A Survey of British Practice in the Carbonization of Coal at Low Temperatures and a Detailed Description of the Construction and Operation of the Experimental Plant of Low-Temperature Carbonisation, Ltd., at Barugh, Near Barnsley

By DAVID BROWNLIE
Manager and Director, Brownlie & Green, Ltd.

THE general principles of the process of low-temperature carbonization are already well known and many articles and papers have been published on the subject, both in America and in Europe. The essential facts of the three processes of carbonization as they are carried out in Great Britain are shown in Table I.

It may seem a simple matter to carbonize coal at a lower temperature, but in practice the difficulties are extraordinarily complicated. When coal is heated it softens and swells and the maximum expansion seems to be at about the temperature of 550 deg. C. (1,022 deg. F.). The consequence is that in an ordinary retort

This does not matter much in high-temperature processes except that 5 per cent or so of the gas is wasted, but for low-temperature carbonization it is fatal, since this gas burning in the retort flues alters and raises the temperature, so that all control is lost, in addition, of course, to the loss of rich gas.

Another difficulty is that coal is a bad conductor of heat, and to submit every portion of a given mass of coal to a definite temperature of 550 deg. C. (1,022 deg. F.) means that the carbonization must take place in comparatively thin layers.

It is often stated that if low-temperature carbonization is required, all that is necessary to do is to lower the temperature of the ordinary retorts. The result of this is to form coke on the outside layers in the retort and practically unchanged coal inside. A mixture of half-baked coal and coke is not the product desired, which is a homogeneous product in a peculiar physical condition of porosity and texture.

One of the most difficult problems to solve was the material of the retorts. The difficulty with cast iron or mild steel is that when subjected to a continuous red heat it begins, almost in a few weeks, to waste away and also to "creep" or alter its shape. If cast iron could be used, it would be an ideal material, because it is a good conductor of heat, absolutely non-porous to the gas produced in the process, and can easily be cast accurately to any dimensions required.

In the early days of the gas industry in Great Britain, when the wear and tear on the retorts was much more severe than for low-temperature carbonization, although the temperature in those days certainly not as high as in the present gas industry, cast-iron retorts were used and usually lasted several years. This probably led to Parker's persevering tests with cast iron. The attempts were finally abandoned, however, and firebrick retorts were constructed, on the original advice of Prof.

TABLE I. YIELDS FROM ONE TON OF AVERAGE COAL (25-35 PER CENT VOLATILE MATTER) IN THREE PROCESSES OF CARBONIZATION (BRITISH PRACTICE)

Process	Low-Temperature Carbonisation	High-Temperature Carbonisation	
		Gas Works	Coke Ovens
Temperature of carbonisation.....	1,000 deg. F.....	About 1,800 deg. F.	About 1,800 deg. F.
Gas.....	6,000-6,500 cu.ft. of rich gas, 700-750 B.t.u. per cu.ft....	12,000 cu.ft. of medium quality (city) gas 550 B.t.u. per cu.ft.....	11,500 cu.ft. of poor quality (coke-oven) gas 450 B.t.u. per cu.ft.....
Liquid.....	20 gal. of oil (fractionated to 3 gal. motor spirit, 8-9 gal. Diesel oil and 8-9 gal. lubricating oil.....)	10 gal. coal tar.....	8 gal. coal tar.....
Sulphate of ammonia.....	15 lb.....	25 lb.....	28 lb.....
Residue in retort...	1,568 lb. of smokeless fuel (9-10 per cent volatile matter).....	1,512 lb. of soft coke (about 1 per cent volatile matter).....	1,568-1,624 lb. of hard metallurgical coke (less than 1 per cent volatile matter).....

the residue is wedged tight in the retort as a slightly viscous mass and cannot be withdrawn. In high-temperature carbonization this trouble does not exist, because as the temperature increases the viscous materials are decomposed and the coke contracts again in volume, so that it comes out of the retorts without trouble. When the hot coke is taken out of the coke ovens into the air it gives a short flash of flame and is then quenched with cold water, retaining its shape and texture. If the hot residue from the low-temperature process is handled in this way, it blazes furiously because of the higher percentage of volatile matter (9 to 10 per cent) present, and when quenched with water it cracks up, loses its texture and eventually falls to "breeze."

DIFFICULT PROBLEMS IN RETORT CONSTRUCTION

As regards the material of the retorts, the ordinary firebrick retort is porous at the high temperature to the gas formed, which then burns outside the retorts.

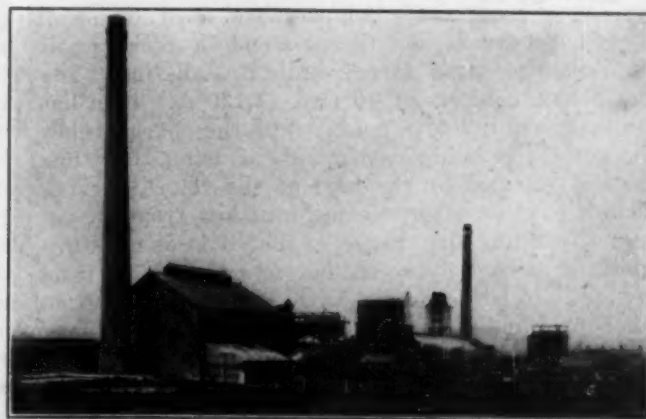


FIG. 1. GENERAL VIEW OF EXPERIMENTAL PLANT AT BARUGH, NEAR BARNSELY

V. B. Lewes. It is very likely, however, in the future that cast iron may be experimented with again in view of present research into the constitution of metals.

EXPERIMENTAL PLANT AT BARUGH, NEAR BARNSELEY

With this brief outline of some of the problems presented by the low-temperature process, it is the intention of the writer to describe in considerable detail the experimental plant of Low Temperature Carbonisation, Ltd., which is located at Barugh, near Barnsley, in the center of the Yorkshire coalfields. This plant is in reality a good-sized works, as may be from Fig. 1. It consists of a unit of twenty retorts with a capacity of about 30 tons of coal a day, and with a complete recovery plant, coal washers, scrubbers, benzene-rectifying house, gasometers, producer gas plant, power station, etc., sufficient to handle the products from four or five times the present number of retorts. However,



FIG. 2. VIEW OF RETORT HOUSE

since the whole process depends on the retorts, the company decided to confine itself to one unit of twenty retorts until complete success was obtained, as the erection of future units of retorts is a simple matter.

Each of the twenty retorts consists of a coal hopper at the top, a carbonizing retort beneath, and below this retort, a cooling retort, as shown in detail in Figs. 2 and 3.

The coal to be carbonized, which has first been washed, is fed into the hoppers, and each hopper holds exactly one charge of coal. These hoppers can easily be supplied mechanically with the coal by means of a horizontal scraper or other conveyor, so that when one hopper is emptied it is immediately refilled automatically. At present these hoppers are filled by small hand-propelled trucks, but this is simply a minor detail to be remedied in a larger scale installation. The charge, which consists of 10 cwt. (1,120 lb.) then lies in the hopper for 7 to 8 hours while the charge below in the retorts is being carbonized. During this time it becomes warmed by the heat of the retort, serving the double purpose of preventing heat loss from the retorts and warming the charge so that it loses moisture and does no damage to the red hot retort when the time comes for it to be dropped down. Between the bottom of this hopper and the top of the retort is a heavy rotary door or valve, operated by hand by means of a long lever, as shown in Fig. 4. When the retort below has been emptied, the attendant pulls the lever and lets the warmed charge of coal in the hopper fall into the hot retort. The retorts are of the vertical pattern, the

inside dimension of each retort being about 9 ft. 0 in. x 6 ft. 6 in. x 11 in. They are built of firebrick cemented with fireclay into one unit of twenty retorts complete with all the necessary flues. All future plants, no matter how large, will be an aggregation of these standard units of twenty retorts each.

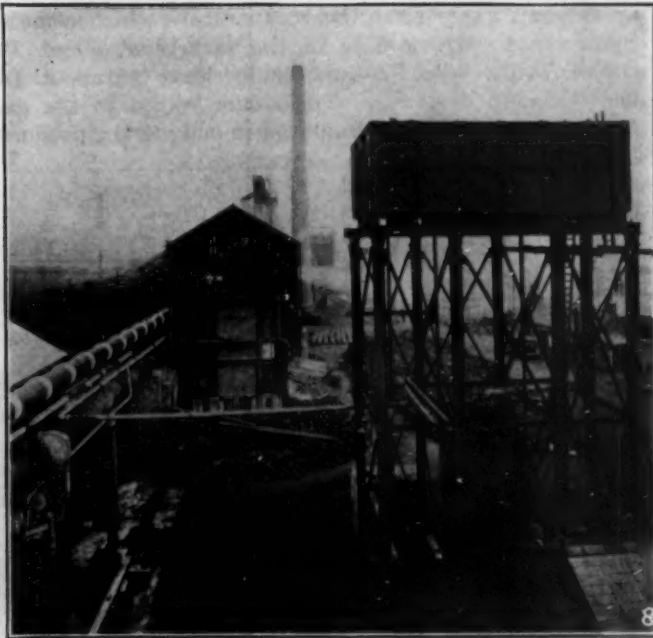
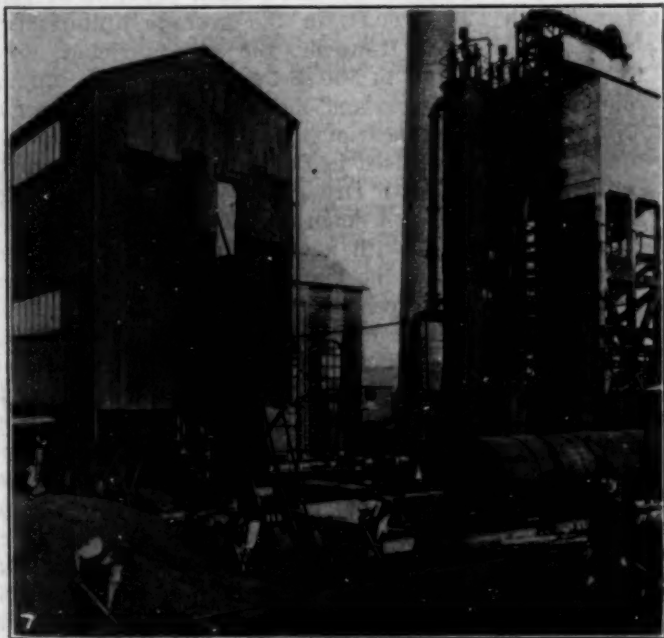
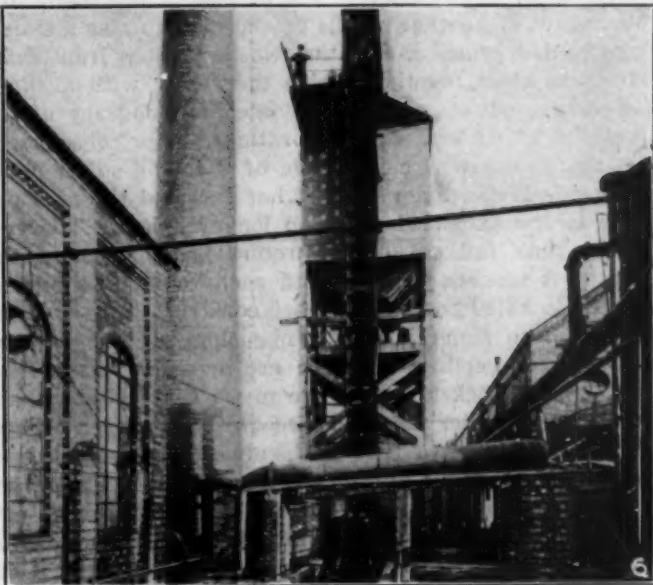
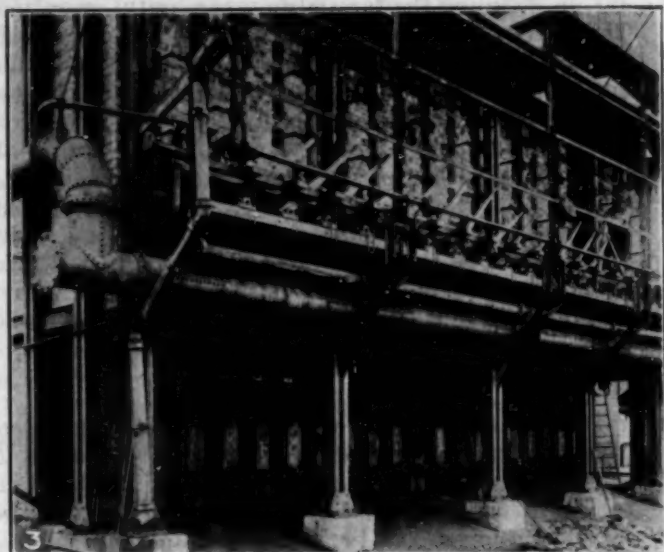
DESCRIPTION OF RETORTS

Inside each retort are two vertical perforated cast-iron plates extending for practically the entire height of the retort; the distance between these plates is about 4 to 5 in. The coal falls down into the retort from the hopper above, and fills each of the two empty spaces between the side of the retorts and the plates, but it cannot fall between the plates. That is to say, when full, each retort contains two vertical masses of coal 9 ft. 0 in. x 6 ft. 6 in. x 3 to 3½ in. thick, separated by two perforated iron plates, and an empty space 4 to 5 in. wide between the plates.

HEATING THE RETORTS

The retorts are heated by a series of burners on the outside (as shown in Fig. 2) supplied by producer gas (or if necessary by the rich gas from the process); the burner flues between retorts are situated horizontally one above the other. The exit flue gases pass downward at the end of each horizontal flue, and into a similar flue below, regenerated at each flue by supplementary burners until the bottom of the retort is reached, where they then pass through the "recuperators" to the chimney exit of the plant. The fresh cold air supply for the burners passes through these recuperators and is thus preheated. The amount of heat lost by the whole battery of retorts is remarkably small, and the complete installation has a heat efficiency of about 75 per cent. The heat required to carbonize 1 ton of coal is about 2,500,000 B.t.u., equivalent to about 10 per cent of the coal—that is 2 cwt. (224 lb.) of coal or coke per ton. In a modern coke oven the heat required to carbonize 1 ton of coal is about 3,000,000 B.t.u. The burners are provided with spy holes in the brickwork, and the necessary temperature of about 650 deg. C. (1,202 deg. F.) in the flue outside, equivalent to about 550 deg. C. (1,022 deg. F.) inside the retort, can be obtained by adjusting the gas supply in accordance with the color of the flame. The latter operation is based on experience gained originally by the aid of pyrometers.

The exact temperature to use depends to some extent on the nature of the fuel required, the quality of the coal used and the yield of different products (depending on the market prices at the moment), but the figures previously given are about the average. The carbonization then proceeds for 8 hours, although it is possible that this time will be cut down in the future to 7 hours, or perhaps even to 6. To prevent the gas leakage through the sides of the retort, the top of the retort communicating with the empty space between the two vertical plates is connected direct to the exhausters, so that there is a slight suction down the center of the retort. Because of the perforated plates practically every portion of the heated mass of coal (in thin layers) is in direct communication with the suction space. Consequently, the distillation products, all gaseous at the temperature of 550 deg. C. (1,022 deg. F.) pass directly out of the coal into this central chamber through the perforations and up out of the retort. They have not to pass, as with an ordinary retort,



FIGS 3 TO 8

Fig. 3. The unit of twenty retorts.
 Fig. 5. Withdrawing low-temperature coke from cooling chambers.
 Fig. 7. Coal washer and benzene scrubber.

Fig. 4. Charging coal into retorts from coal hoppers.
 Fig. 6. Conveying coal from washers to carbonizing retorts.
 Fig. 8. General view showing 20-in. concrete gas main to retort house.

through a mass of hot coal a number of feet in height, which partly decomposes the products and at the same time causes a pressure in the retort, thus increasing the tendency for these products to pass through the fireclay sides. This objectionable tendency in an ordinary retort is helped also by the chimney suction in the burner chambers outside of the retorts, and any suction at the top is lost after passing a few inches down into the mass of coal.

With these retorts containing the perforated plates, however, the suction is applied at once to every portion of the mass, and no gas at all passes through the retorts the reverse way into the flues. The gaseous products pass out of the retorts into the recovery portion of the plant in the usual way, and the after-treatment is the same as that of a coke oven.

DISCHARGING THE HOT FUEL

When the carbonization is completed, the attendant, by means of a hand lever, opens a heavy horizontal circular or rotary door in the bottom of the retort and by means of another handle on the top actuates a simple mechanism which causes the two perforated iron plates to come close together inside the retort with a slight shearing motion, so as to obviate any tendency of the residue to stick in the perforations. The consequence is there is now a clear space of 2 in. or so all down one side of the huge slabs of hot fuel and the pressure due to the expanded mass no longer exists. The two slabs thus fall out of the retort bodily without the slightest trouble. Underneath each retort is a special water-jacketed cooling chamber constructed of steel, of exactly the same internal dimensions as the retorts. These steel cooling chambers are in reality waste-heat boilers, the jackets being able to work at 100-lb. steam pressure. Water is circulated through these jackets, and the hot slabs of fuel, in the almost complete absence of air, lie in these cooling vessels while giving up their heat to the cooling water. In practice the temperature of the water in the jackets is generally over 212 deg. F. and steam is generated at about 5 lb. pressure. These jackets are also arranged to be heated by the exit gases from the recuperators which come in contact with the surface of the jackets at about 300 deg. C. (572 deg. F.) and finally leave at about 130 deg. C. (266 deg. F.). The steam raised in the exit chimney of the plant is employed in making the producer

gas, in distilling the tar and in other useful operations. The vertical side of these cooling chambers is composed of a door, which is opened, and the fuel pulled out by hand rakes on to the sloping cement floor (see Fig. 5) and slides down to the store or direct into trucks, being a hard, porous, compact solid, only warm to the hand. The product is so hard that it is superior in this respect to briquets. The pieces are thrown into railway cars in the same manner as coal, and travel quite as well as coal itself; the breeze formed is infinitesimal. Thus the product is now arriving regularly at Marylebone station (London) from Barnsley, 200 miles away, in perfect condition.

ECONOMIC CONSIDERATIONS

The cost of labor and attendance in working a complete low-temperature carbonization plant is about the same as that of a coke-oven plant. The whole of the recovery side of the plant, constituting about 60 per cent of a complete low-temperature installation, is practically identical with that of existing high-temperature carbonization processes. The balance sheet of the whole process is very satisfactory, even on a conservative estimate of the market value of the various byproducts of gas, motor spirit, Diesel oil, lubricating oil and sulphate of ammonia produced, especially since the fuel can replace coal in practically any operation, household or industrial.

The coal used, while it must be of the dimensions of ordinary slack, can be of the most varied composition. A remarkable achievement is that two parts of non-coking coal can be mixed with one part of coking coal and used to produce a very satisfactory smokeless fuel. The importance of this will be obvious, as it means that practically all the coals of Great Britain can be subjected to this process. Another noteworthy achievement is that a large proportion of fine slack and dust, now practically a waste product of the collieries, can also be utilized, and the importance of this to the colliery industry can hardly be overestimated.

Gas. As already noted, the yield of gas is considerably lower, 6,000 to 6,500 cu.ft. per ton, as compared with 12,000 cu.ft. in the average high-temperature gas works. However, the gas is richer, since it yields about 700 to 750 B.t.u. per cu.ft., as against 550 B.t.u. for city gas and 450 B.t.u. for coke-oven gas. Naturally the composition of the gas depends on the quality of the coal used in the low-temperature retorts, but as compared with city gas it is richer in methane and olefines and has a much higher illuminating power. Roughly speaking, with average coal of about 30 per cent volatile matter, the composition of low-temperature gas is about 27½ per cent hydrogen, 48 per cent methane, 10 per cent paraffine hydrocarbons, 3 per cent olefines, 7½ per cent CO, 2½ per cent CO₂, and 1½ per cent nitrogen.

Oil. The oil from the process resembles crude oil in appearance and is quite different in composition from coal tar. It has a specific gravity of about 1.06 and contains less than 1 per cent of free carbon, while coal tar has a specific gravity of about 1.18 with a large amount of free carbon, generally over 6 per cent, which is caused by the excessive decomposition resulting from the higher proportion of the simpler and lower organic compounds of the benzene and cresol groups, with no phenol and an almost entire absence of the higher hydrocarbons of the type of naphthalene, anthracene, carbazol, etc.; the percentage of pitch is also much less. About 45 per cent of the low-temperature oil comes

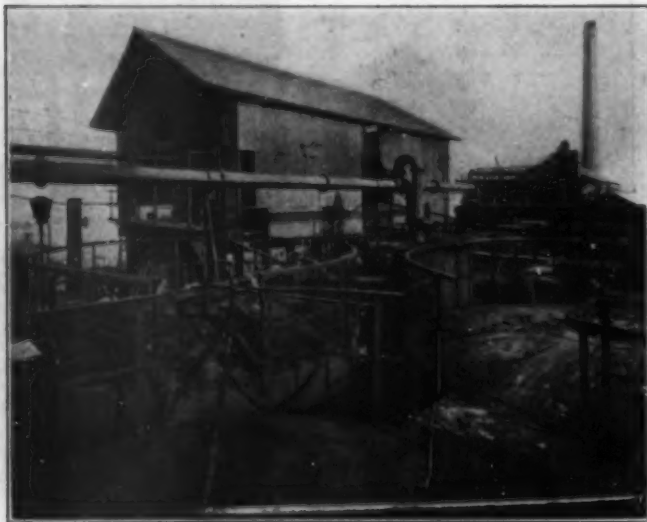


FIG. 9. RETORT HOUSE, WITH STORAGE TANKS FOR OIL IN FOREGROUND

over between 160 and 300 deg. F., while with coal tar the figure is only about 12 to 14 per cent.

It is curious that cresols, which are very valuable for wood preservatives, are present in large quantities in this oil, corresponding to about 3 gal. per ton of coal. In coal tar the chief product of this class is phenol or carbolic acid, and there is very much less cresol. Naphthalene is entirely absent in low-temperature oil and present in large quantities, 5 to 10 per cent, in coal tar, which reduces the value of the latter in comparison.

The large amount of motor spirit produced, about 2 to 3 gal. to the ton of coal, depending on the quality, is a very valuable product. It has a particularly low freezing point, about -50 deg. F., whereas benzene is about +40 deg. F.

The fraction above 300 deg. F. amounts to about 42 per cent. It is then treated by steam, whereby valuable lubricating oils are removed, leaving about 34 per cent of pitch; and from this further heavy lubricating products such as vaseline can be extracted. In this pitch residue there is less than 6 per cent of free carbon, whereas in the ordinary pitch from coal tar there is a very large amount, generally about 28 per cent.

A large portion of the oil, after removing the pitch, can be used direct as Diesel oil, corresponding to 8 or 9 gal. per ton. It works perfectly, starting from cold and giving results of about 0.5 to 0.55 lb. of oil per brake horsepower.

Sulphate of Ammonia. This is extracted from the gas in the usual way by means of sulphuric acid, the yield being about 15 lb. per ton of coal, less than the high-temperature carbonization processes because the decomposition of the nitrogenous matter in the coal is less drastic due to the lower temperature.

Smokeless Fuel. This is a hard, crisp and porous solid, which contains about 8 to 9 per cent of volatile matter. The actual B.t.u. is about the same as the coal from which it is manufactured, but the effective heating value is for many uses higher because of the emission of much more radiant heat in the burning. Like coke, it is absolutely smokeless. Black smoke is of course due to the escape of unburned matter, as the rate of combustion is too slow to complete the oxidation before the smoke can escape. For this reason anthracite, which contains very little volatile matter, and coke, which contains none at all, are absolutely smokeless. As the fuel from the low-temperature process is also smokeless, it would appear that any amount of volatile matter up to about 12 per cent can be burned without trouble, but when over this, black smoke begins to appear. It is also clean and not dusty like coal, and ignites almost as easily as coal, unlike coke, which is very difficult to light. Like coke it too is a highly efficient fuel for steam generation because of the high radiant heat.

² Austin Friars,
London, E. C. 2.

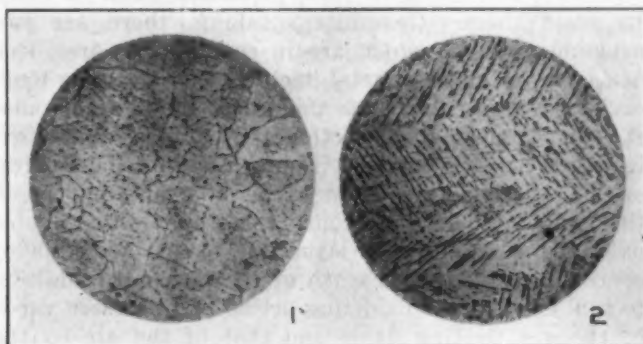
Tests of Rubber Goods

Standard methods of testing rubber goods of all sorts are described in the new (fourth) edition of Circular 38 of the Bureau of Standards, which is now available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 20c. per copy. The circular also includes a brief discussion of crude rubber and the manufacture of rubber goods, both the composition and the methods of manufacture.

Oxygen and Nitrogen in Welds*

By S. W. MILLER

IT IS known that a weld made with a low-carbon steel wire for welding rod is usually an over-oxidized steel casting, and its maximum strength cannot be in excess of 52,000 lb. per square inch. If nickel steel wire (S.A.E. 2320) is used, however, its strength can be kept up to 58,000 lb. per square inch by careful and competent workmen, and its state of oxidation is much less. This seems to be due to the formation during welding of a tough viscous slag, which is probably due to the formation of nickel oxide. This coating on the weld is very thin, but seems to be sufficient largely to protect the metal from the action of the air. Whatever the cause may be, the microstructure of the weld



FIGS. 1 AND 2.

Fig. 1. Gas weld in sheet steel. Notice large grain size due to heat. Small dots are ferrous oxide. A few particles of carbide at grain boundaries. Etched. $\times 200$.

Fig. 2. View in weld made with 0.20 carbon, 3 1/2 per cent nickel steel wire. The carbon is largely preserved by the nickel, making the weld pearlitic and stronger than one made with ordinary wire. $\times 100$.

shows it to be much more free from ferrous oxide than ordinary weld metal. (Compare Figs. 1 and 2.) Any material will answer that will give equal results. But nickel steel is readily obtainable and, until other alloys are found, I feel that nickel steel should be used for important work.

It is just as necessary to have high quality in the base metal as it is in the welding rod, and I might say at the beginning that I have never found a bad welding steel that was not full of sonims, nor a good welding steel that was not free from them, except in one or two instances. I believe it is possible to make a bad welding steel by improperly annealing good material, especially in sheet, where the effect of oxidizing atmosphere is much greater in proportion than in plate, because of the thinness. The effect is to make the material brittle, presumably by permitting the oxygen to penetrate the grain boundaries, being in effect an incipient burning. It has been shown that by heating in a reducing atmosphere at a temperature below the A_c point the brittleness was removed, which would seem to show that oxide films at the grain boundaries caused the trouble.

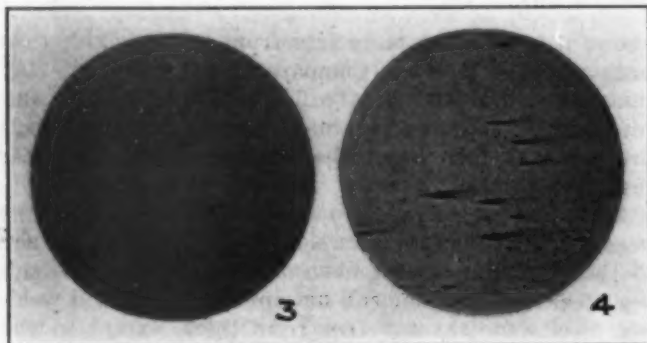
The nature of the non-metallic impurities that cause trouble in welding I am not sure of, because they are usually very small, but as the metal just around them seems to be porous to a greater or less extent, it would seem that they must be oxides or silicates. It is also quite probable that the porous part is filled with gases, because bad welding material spits when it is heated to the welding point, indicating that gas has been

*Extracts from a paper read before the American Iron and Steel Institute, Nov. 18, 1921.

formed in some way. It is also noticeable that in preparing a specimen for the microscope the later grindings, if done on soft cloth, remove the material around the sonims and give the unetched section the appearance of being spotted with a lot of comet tails, which of course are much larger than the actual size of the particles of impurities.

I think it is perfectly safe to say that the microscope will always determine whether a steel will weld properly (see Figs. 3 and 4), except where it has been put through an annealing process which would damage it at the grain boundaries. I also feel that chemical analysis shows nothing of the welding qualities within wide limits, unless the steel is badly off.

The microscope shows better than any other instrument the nature of the defects in welds, and when this is known, and not until then, precautions can be taken to avoid them. Generally speaking, there are two avoidable defects, which are in reality one—first, lack of fusion in the weld metal itself. (Fig. 5.) The tendency in welding steel is to underheat the plate, because it is much heavier in section than the welding wire, in which case the melted wire may fall into the V without being fused to it. The same thing may happen in the weld. When this occurs there is a thin film of oxide between the two layers of metal, and this of course destroys the strength of the piece. In addition to this there is the oxidizing action of the water vapor in the gas welding flame and that of the air on the finely divided metal passing through the electric arc. If the gas welding flame be not properly adjusted, or if the torch be of poor design, there is the additional possibility of free oxygen being present and causing

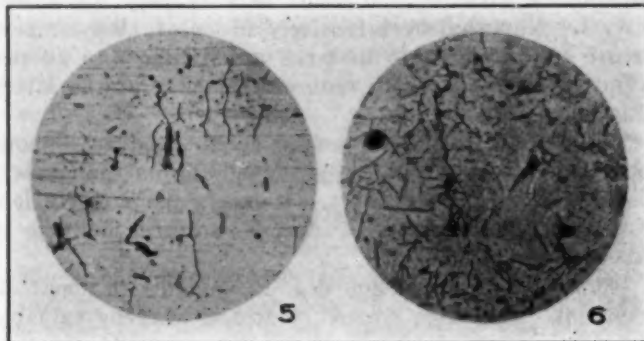


FIGS. 3 AND 4.

Fig. 3. Good welding steel. Sonims few and small. $\times 35$
Fig. 4. Poor welding steel. Sonims larger and more numerous than in Fig. 3. $\times 35$.

serious trouble. An improperly made weld will show streaks of oxide or other impurities which are frequently very small and thin, and yet the first evidence of distortion of such a weld is at these defects, just as the first evidence of distortion in a piece of steel is at similar defects. During the welding operation these defects appear as bright white spots or streaks in the case of gas welding, which can be floated to the surface and removed. In the case of electric welding this is not possible, except to a limited extent, because whatever impurity is in the electrode must go into the weld. The films or streaks referred to are frequently clearly visible under the microscope, but many times rupture occurs at the grain boundaries in both gas and electric welds, where there are no evidences of any films even at the highest power of the microscope. (Fig. 6.) These ruptures must be at the austenite grain boundaries, because to

them the impurities are rejected during the solidification of the metal. In cases of welds where it is possible to distinguish between the gamma and the alpha grain boundaries, as is possible when there is much pearlite, I have never seen a case of rupture at the alpha boundaries. This would seem to be quite natural,



FIGS. 5 AND 6.

Fig. 5. Defective gas weld, full of laps. $\times 200$.
Fig. 6. Electric weld. Grain boundary rupture; no evidence of defect before straining. $\times 200$.

because the alpha grains are formed by the recrystallization of the gamma grains, and if there be any impurities at the gamma grain boundaries it is not possible for one grain to grow at the expense of another one past such impurities.

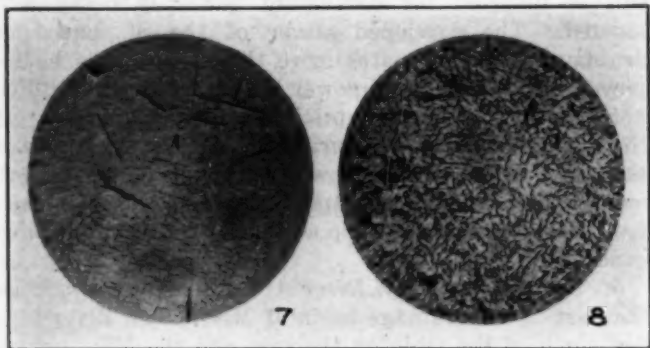
It would scarcely be expected that any ordinary heat-treatment would alter the character of the ruptures in welds, and if defective welds were heated in an oxidizing atmosphere it might be expected that they would become more brittle. Such tests as I have made indicate that this is true. On the other hand, I have found that electric welds which were very brittle as made were notably improved by heating several hours in a strongly reducing atmosphere at a temperature of about 600 deg. C. This would indicate that the difficulty is one of oxide.

PREVENTION OF OXIDATION

Oxidation should evidently be less severe in the case of gas welds than in electric welds. First, because the temperature is not so high, and second, because of the protecting influence of the envelope flame, which is composed of hydrogen and CO burning to water and CO₂. In the electric arc the temperature is very high, and the metal passing over the electrode to the weld is very finely divided, with naturally great oxidation. It will appear clear that if the melted metal could be covered with a protecting slag, oxidation would be much lessened. This has been done for a number of years in electric welding by coating the electrodes with compositions of various kinds which produce slags of various viscosities. If the slag is too viscous, it may be entangled in the weld, weakening it, and if too thin, it will not protect the metal; but it is a fact that electrodes of this type when properly used give a sounder weld than electrodes made of bare wire. With gas welding no organized attempt has been made to provide such a slag covering. Naturally with the lower temperature a thinner slag will be necessary, but there is also to counteract this the blast from the flame, which has a velocity of about 375 ft. per second at the exit from the tip, which tends to blow away the slag and to leave the metal exposed. It is rather curious that nickel steel welding rod seems to provide a very thin slag. It is entirely probable that before best results will be ob-

tained with gas welding it will be necessary to provide a properly coated welding wire. It might be mentioned incidentally that in the case of non-ferrous metals such as brass and bronze, much sounder welds are produced when the welding material contains slag-forming constituents and when flux is sparingly used than when other conditions prevail. This would naturally be expected, because of the well-known fact that a clean surface of melted metal permits the absorption of gases which are given out during solidification, causing porosity.

Welding rods are low in carbon (that for gas welding having about 0.06 per cent and that for electric welding about 0.15 per cent¹), yet there is always a loss of carbon due to the heat, so that the weld made with



FIGS. 7 AND 8.

Fig. 7. Nitrogenized iron. Primary and secondary plates of iron nitride. The primary ones (large) appear to lie along Neumann directions, while the secondary ones (small) appear to be parallel to the intersection of an octohedron by a cube face in two grains, and in the third (upper left corner) along intersections of an octohedron with dodecahedral planes; the larger plates do not appear where the small ones are. Etched with picric acid. $\times 200$.

Fig. 8. Electric weld in 3-in. plate. View in weld. Many iron nitride plates, small in size because of rapid cooling.

such materials does not contain over about 0.03 or 0.04 per cent of carbon. Manganese and silicon are also lost, but, as would be expected, the phosphorus and sulphur do not change. In the case of heavy welding the loss of the above elements is less near the V than in the center of the weld, as there is some interchange of the elements between the weld metal and base metal, so that in sampling a weld for chemical analysis care should be taken to keep away from the edge of the V, unless proper allowance is made.

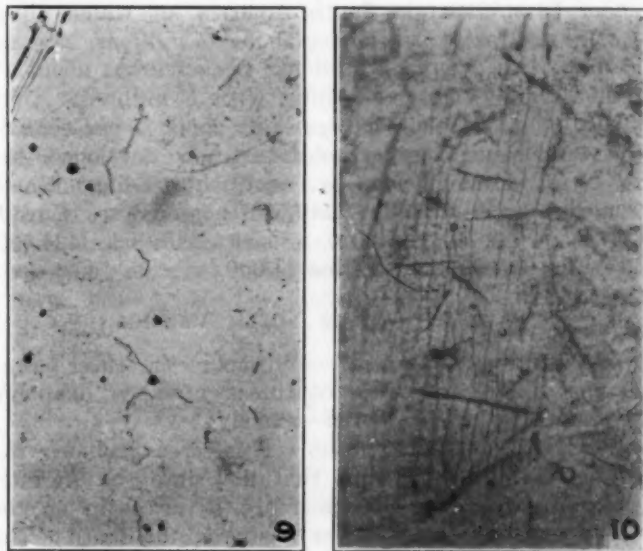
While there is a loss of some elements, there is a gain in both oxygen and nitrogen. Nitrogen in both gas and electric welding comes from the air, while the oxygen probably also partly comes from the water vapor in the envelope flame in the case of gas welding. It is generally believed that molecular nitrogen has but small affinity for iron at even high temperatures, and this is doubtless true. On the other hand, iron ordinarily combines with nitrogen in the nascent condition at 1,400 deg. F., as has been proved by numerous tests.

There has been much discussion as to the effect of nitrogen on steel, some taking the position that it makes steel brittle and others that it has very little if any effect. The presence of nitrogen as nitride can be quite accurately determined by chemical analysis, but its existence in other forms, such as dissolved gas, cannot be proved in this way. It is usually believed that when

¹While Armco iron does not come within the chemical limits given, the ratio of the strength of a weld made with Armco wire is to its plate strength about the same as that of a nickel steel weld to the plate specified. Also such non-metallic impurities as exist in Armco iron do not seem to impair its welding qualities. They are apparently of a different character.

it is present in sufficient quantity it combines with the iron, making an iron nitride having the formula Fe_3N . In this condition it may be seen as a constituent of the metal in the form of plates (Fig. 7) lying along the cleavage planes of the grains, and with larger quantities is present as a eutectoid of iron and iron nitride at the grain intersections.

Electric arc welds have the same structure as nitrogenized iron, except that the structure is much finer because of the rapid cooling. (Fig. 8.) Gas welds may also contain the plates when the metal has been overheated. Similar plates are also visible in samples of bessemer steel taken just after the blow and before recarburizing. (Fig. 9.) In all three cases the metal has been overheated, and it would seem to be quite possible for nitrogen to combine with iron as iron nitride at these very high temperatures. Of course there is as yet no chemical proof that the plates are iron nitride, as they have not been isolated. It is not worth while to discuss the matter here, except as to



FIGS. 9 AND 10.

Fig. 9. Blown steel from bessemer converter. Short lines at left are iron nitride. Cementite at grain boundaries at right. $\times 300$.

Fig. 10. Electric weld strained. Slip bands frequently stop at iron nitride plates, but in no case do they follow along them, nor do the plates influence the slip bands. $\times 500$.

whether nitrogen is responsible for the brittleness in electric welds made with bare wire. I have tested many welds by bending them and examining them under the microscope, and in no case has it been found that the nitride plates have any effect on the path of rupture. The slip bands in the grains never follow the plates (Fig. 10), but frequently stop at them when the two are at an angle to each other, and the rupture takes place either at defects in the weld, or at the grain boundaries, even where in the latter case no defects are visible, as they also sometimes do in the case of gas welds. This would indicate that as far as tensile stress is concerned nitrogen has no serious effect. In the case of alternating stress and shock tests, the results might be different, but no such tests have been made as far as I know. It seems to me that in view of all the facts the brittleness of welds is due to the presence of oxides, and I believe that in the future we shall be able to make much better welds by providing some effective but simple means for the protection of the melted metal from the air, or for removing from the weld the oxides as they are formed.

Water-Power Resources of the World

THE water-power resources of the world and their present development form the subject of Part II of the World Atlas of Commercial Geology, by Herman Stabler, B. E. Jones, O. C. Merrill, N. C. Grower and a group of other co-workers of the United States Geological Survey.

The extreme ultimate development, with the greatest possible conservation of stream flow by storage, of the potential waterpower of the world may reach as high as 10 billion horsepower, but such a figure is purely speculative. The reasonable estimate, when the streams are at ordinary low water stage, is about 440 million horsepower, an amount equal to nearly four times the world's present total used power from all sources. Of this last estimated amount about 190 millions are in Africa, especially in the tropical zone; about 70 millions in Asia, China and India, having respectively 20 and 27 millions; about 62 millions in North America, the United States and Canada having respectively 28 and 20 millions; about 54 millions in South America, of which about half is in Brazil; Europe has about 45 millions, Norway leading with about 5.5 millions; Oceanica has about 17 millions, New Guinea leading with 5 millions. Only about 23 million horsepower—i.e., about 5 per cent of the total reasonable estimate—is now developed, the rank of developments by continents being: North America with about 12,210,000 horsepower, Europe 8,877,000, Asia 1,160,000, South America 424,000, Oceanica 147,000 and Africa 11,000.

WATER POWER IN NORTH AMERICA

In outlining the general conditions of the water power in the North American continent nineteen drainage areas are to be considered—namely:

1. *Middle Atlantic Area.* This area includes the basins of all the streams that flow into the Atlantic Ocean between the St. Lawrence River basin on the north and the James River basin on the south. The large demand for power in this most densely populated area of the Western Hemisphere has resulted in the utilization of a great percentage of all the fall sites.

Of the potential 400,000 hp. in New Brunswick, Nova Scotia and Prince Edward Island, about 54,000 hp. is already developed; a 12,000-hp. plant is now being built in Nova Scotia.

The New England water power has been extensively developed. Of the maximum potential 1,605,000 hp. available 1,381,000 is already developed, the principal users, besides public utilities, being pulp, paper, cotton and woolen mills.

Of the maximum potential 2,488,000 hp. in the Middle Atlantic States 1,735,000 is already developed, especially on the Hudson, Mohawk, Delaware, Susquehanna and Potomac rivers. There are also fairly large plants on the Lehigh, Schuylkill and Shenandoah rivers. Most of the developed power is used by public utility plants.

2. *South Atlantic and Eastern Gulf of Mexico Area.* This area includes the basins of all streams that flow into the Atlantic Ocean or the Gulf of Mexico between the Middle Atlantic area and the Mississippi River. Of the minimum 2,000,000 hp. about 1,500,000 is already developed. The greater part of this power is used mainly in cotton mills, although mines, iron and steel mills and miscellaneous manufacturing plants also are great users of water power.

3. *Ohio River Area.* This area includes the entire

drainage basin of Ohio River. The potential power of this basin is about 1,500,000 hp., of which only about 400,000 has been developed. A large part of the power developed is for municipal purposes, but practically all the new power development now going on is for industrial use, largely for making cotton goods and aluminum.

4. *St. Lawrence River Area.* This area includes the drainage basin of the Great Lakes and St. Lawrence River to its mouth at Pointe des Monts. The plants near Niagara Falls form the largest water development in the world; their total capacity is 870,000 hp., of which 385,500 is on the United States side. If the total flow of the river were used the Falls would furnish, under favorable conditions, about 6 million horsepower. A plan whereby 60 per cent of the total flow of the river can be diverted for developing power is being considered. The developed power of the St. Lawrence drainage area aggregates more than 2.5 million horsepower, and the potential power is estimated at 10 million horsepower, on the assumption that only 60 per cent of the available flow at Niagara Falls may be diverted for this use. Most of the power developed is applied to municipal uses, but great amounts are also used in electrochemical industries, pulp and paper mills, mining and general industrial plants.

5. *Upper Mississippi River Area.* This area includes the part of the drainage basin of Mississippi River that lies north of the Ohio on the east and the Missouri on the west. The potential power of this area is estimated at about 1 million horsepower, of which 600,000 has already been developed. The power is used mainly for municipal purposes, but mills manufacturing paper, flour, wood products and other articles also use large amounts.

6. *Missouri River Area.* This area includes the entire drainage basin of the Missouri River. Of the total potential 4.4 million horsepower in this area (Montana, Wyoming, Colorado, South Dakota) only about 570,000 is developed. The power developed is utilized principally for mining, smelting, railway and municipal uses.

7. *Lower Mississippi River Area.* This area includes the parts of the Mississippi drainage basin that lie south of the Missouri and of the Ohio. There are only a few water plants in this area, all small.

8. *Western Gulf of Mexico Area.* This area includes the drainage basins of all streams that flow into the Gulf of Mexico between the Mississippi River and Cape Catoche in Yucatan. Only about 150,000 hp. is developed. There is about 50,000 additional potential horsepower on the Necaxa and about 200,000 on the Rio Blanco. Mines and municipal uses offer a market for a large amount of power in this country.

9. *Gulf of California Area.* This area includes the Colorado River drainage basin in the United States and extends to Capes San Lucas and Corrientes in Mexico. The potential power in this basin is estimated to be at least 2 million horsepower, of which less than 200,000 is developed.

10. *Great Basin Area.* This area includes the inland basin between the Rocky Mountains and the Sierra Nevadas. With proper storage the potential power in this area would amount to 500,000 hp. The plants now constructed have a capacity of 250,000 hp.

11. *Upper South Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between the northern boundary of the Klamath River basin and the south end of Lower

SUMMARY OF POTENTIAL AND DEVELOPED WATER POWER IN 1920
IN HORSEPOWER

North America		
	Developed	Potential
Mexico.....	400,000	6,000,000
United States.....	9,243,000	28,000,000
Alaska.....	40,000	2,500,000
Newfoundland.....	60,000	400,000
Canada.....	2,418,000	20,000,000
Costa Rica.....	15,000	1,000,000
Guatemala.....	4,000	1,500,000
Honduras.....	3,000	1,000,000
Nicaragua.....	400	800,000
Salvador.....	2,700	200,000
Panama.....	13,300	500,000
West Indies.....	12,500	150,000
Approximate total.....	12,210,000	62,000,000

South America		
	Developed	Potential
Argentina.....	25,000	5,000,000
Bolivia.....	12,000	2,500,000
Brazil.....	250,000	25,000,000
British Guiana.....	25,000	2,500,000
Dutch Guiana.....	800,000	800,000
French Guiana.....	500,000	500,000
Chile.....	60,000	2,500,000
Colombia.....	25,000	4,000,000
Ecuador.....	2,500	1,000,000
Paraguay.....	200	2,000,000
Peru.....	36,500	4,500,000
Uruguay.....	300,000	300,000
Venezuela.....	12,500	3,000,000
Approximate total.....	424,000	54,000,000

Europe		
	Developed	Potential
Sweden.....	1,200,000	4,500,000
Norway.....	1,350,000	5,500,000
Finland.....	185,000	1,500,000
Russia.....	100,000	2,000,000
Estonia.....		
Latvia.....	20,000	200,000
Lithuania.....		
Poland.....	80,000	200,000
Ukraine.....	40,000	425,000
Region of the Caucasus.....	5,000	5,000,000
Hungary.....	30,000	150,000
Czechoslovakia.....	50,000	420,000
Jugo-Slavia.....	125,000	2,600,000
Austria.....	205,000	3,000,000
Rumania.....	30,000	1,400,000
Bulgaria.....	8,000	1,200,000
Greece.....	6,000	250,000
Turkey.....		Small
Albania.....	1,000	500,000
Italy.....	1,150,000	(a) 3,800,000
Switzerland.....	1,070,000	(b) 1,400,000
Germany.....	1,000,000	1,350,000
France.....	1,400,000	4,700,000
British Isles.....	210,000	585,000
Belgium.....	700	Small
Denmark.....	1,500	2,000
Netherlands.....		
Spain.....	600,000	4,000,000
Portugal.....	10,000	300,000
Iceland.....		500,000
Approximate total.....	8,877,000	45,000,000

Asia		
	Developed	Potential
Chinese Republic.....	1,650	20,000,000
India.....	150,000	27,000,000
Asia Minor.....	500	500,000
Arabia.....		
Persia.....		200,000
Afghanistan.....	2,000	500,000
Siberia.....		8,000,000
French Indo China.....		4,000,000
Siam and Malay States.....	4,500	4,000,000
Chosen.....	2,620	500,000
Japan.....	1,000,000	(c) 6,000,000
Approximate total.....	1,160,000	71,000,000

Africa		
	Developed	Potential
Tangier.....		50,000
Morocco.....		250,000
Algeria.....	130	200,000
Tunisia.....		30,000
Tripoli.....		Small
Eritrea.....		Small
British Somali.....		Small
Italian Somali.....		Small
Gold Coast and British mandate in Togo.....		1,450,000
Liberia.....		4,000,000
Sierra Leone.....		1,700,000
Senegal.....		250,000
Rio de Oro.....		Small
Gambia.....		Small
Portuguese Guinea.....		Small
Union of South Africa.....	5,000	1,600,000
Angola.....	4,000	4,000,000
Southwest Africa (Union of South Africa mandate).....		150,000
Belgian Congo and Belgian mandate.....	250	90,000,000
French Congo.....		35,000,000
French mandate in Kamerun.....		13,000,000
Nigeria and British mandate in Kamerun.....		9,000,000
Rhodesia.....		2,500,000
Tanganyika (British mandate).....	800	2,700,000
British Central Africa.....		1,200,000
British East Africa.....	900	4,700,000
Portuguese East Africa.....		3,700,000
Bechuanaland.....		20,000
Abyssinia.....		4,000,000

	Developed	Potential
Egypt.....		600,000
Ivory Coast, Dahomey, and French mandate in Togo.....		2,850,000
French Guinea.....		2,000,000
French Sudan.....		1,000,000
Madagascar.....	100	5,000,000

Approximate total..... 11 000 190,000,000

Oceania (d)		
	Developed	Potential
Australia.....		620,000
New Zealand.....	45,000	3,800,000
Philippine Islands.....		1,500,000
Sumatra.....	(e) 11,600	2,000,000
Java.....	(e) 56,500	500,000
Borneo.....		2,500,000
New Guinea.....		5,000,000
Tasmania.....	34,500	400,000
Celebes.....		1,000,000

Approximate total..... 147,000 17,000,000

Recapitulation		
	Developed	Potential
North America.....	12,210,000	62,000,000
South America.....	424,000	54,000,000
Europe.....	8,877,000	45,000,000
Asia.....	1,160,000	71,000,000
Africa.....	11,000	190,000,000
Oceania.....	147,000	17,000,000

Approximate grand total..... 23,000,000 439,000,000

(a) Ordinary flow. Ordinary low flow estimated at 2,700,000 hp.
(b) Ordinary low water 900,000. For 9 months, 1,374,000 hp., and for 6 months 2,504,000.

(c) Total power developed, under lease and available at low flow.
(d) All these estimates except those for the Philippines and New Guinea assume the use of storage.

(e) Installed or under construction, November, 1920.

California, at Cape San Lucas. The total developed power in this area in California is more than 800,000 hp., and at the present rate of increase will soon exceed 1 million. The potential power at low water is about 3 million horsepower, but this amount could probably be doubled by storage. The power is used mainly for irrigation, mining, electrochemical industries and public utilities.

12. *Lower North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between the Klamath River basin and the Canadian boundary. The potential power is about 11 million horsepower, of which only 750,000 is developed. The power is used mainly by public utilities.

13. *Middle North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean from the U. S. boundary to and including Yakutat Bay, Alaska. The undeveloped power at known sites is between 2 and 3 million horsepower of which only 250,000 is developed. Probably many large sites of potential power are still unknown.

14. *Upper North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between Yakutat Bay and Cape Prince of Wales. The total developed power in this area is about 65,000 hp., which is used mostly in mining. The undeveloped power is unknown, but may amount to 2.5 million horsepower.

15. *Arctic Ocean Area.* This area includes the northern parts of Alaska, Canada and Greenland. Little is known of the undeveloped power resources of this area, but there seem to be no great concentrations of potential power.

16. *Hudson Bay Area.* This area includes the drainage basins of all streams tributary to Hudson Bay. The potential power is estimated at 5 million horsepower, of which about 225,000 is developed. This power is used for municipal purposes, in pulp and paper mills, in milling and general manufacturing.

17. *North Atlantic Area.* This area includes the drainage basins of all streams that flow into the Atlantic Ocean east of Hudson Bay and north of the St. Lawrence River and Cabot Strait. A 75,000-hp.

plant is said to be feasible on Bay d'Est River in Newfoundland. The only large power plants in this area are in Newfoundland, where 60,000 hp. is developed and used mainly in pulp and paper mills.

18. *Lower South Pacific Area.* This area includes a narrow belt between Cape Corrientes and the eastern boundary of Panama. Although power sites are plentiful and well distributed in most of this area, little power has been developed, because there is little manufacturing and no demand for power except for municipal use in the larger cities.

19. *Caribbean Sea and West Indies Area.* The largest plant in this area is that at Gatun, Panama Canal, of about 13,000 hp. Porto Rico has developed 8,000 hp. of a total potential 25,000 hp. Jamaica has one 1,300-hp. plant. Other small plants are scattered in Honduras, Nicaragua and Cuba.

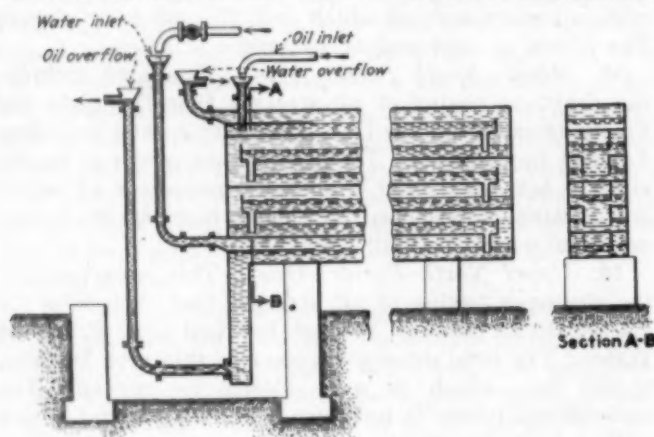
The accompanying tables give the summaries of the potential and developed water power in 1920 by continents and countries.

Direct Type Wash-Oil Cooler for Benzene Plants

BY ARTHUR KUHN

SEVERAL benzene plants in Germany have adopted what is known as the direct method of wash-oil cooling in which the hot debenzolized creosote oil is brought in direct contact with the cooling water, the effect being that the oil is cooled down almost to the temperature of the entering water.

This process, as well as that of the successful direct gas cooling based on similar principles, emanates from Dr. C. Still, and on account of the imperfection of the small testing apparatus a little initial trouble was experienced just prior to the war. The tests were eventu-



DIRECT TYPE WASH-OIL COOLER

ally abandoned, as the cooling effect of a new type of a then inexpensive tubular oil cooler was most satisfactory.

With the present high costs of arranging, cleaning and replacing tubes of the usual coolers, however, less expensive oil-cooling devices are desirable and so the direct cooling has again been taken up and carried through successfully by several coke-oven firms. Though this process is at present confined to European practice, in which heavy tar oil is used in benzene recovery, it will no doubt be of great interest to many coke-oven operators in this country.

Referring to the accompanying illustration, the new type of oil cooler consists of a number of baffle plates

or trays combined in a rectangular box, so arranged that there is always a seal pipe dipping into the oil layer at the bottom of every baffle plate in order that the water may not be mixed with the oil.

The creosote oil, which is heavier than water, enters the cooler a little below the top, whereas the lighter cooling water enters near the bottom. In this way the downward-flowing oil is met by a current of water rising from below. With this constant contact of oil and water the oil is cooled to about the temperature of the entering water.

The separation of oil and water is most satisfactory, provided the water is clean and the oil kept in proper operating condition. Naturally, traces of phenols contained in the oil will be diluted and carried along by the water, but this is of little inconvenience, as the water is used for quenching coke.

The process described refers to the cooling of heavy oil only. It cannot be used for cooling straw oil in the same simple way, as no proper counter-current will be assured. The light straw oil would enter at the bottom and travel in an upward direction similar to the water in the former process, whereas the heavier water would be supplied from the top of the cooler. The result, of course, will be that the cooled oil tends to remain at the bottom owing to its increased specific gravity, while the warm water tends to remain at the top, where the cooled oil leaves the apparatus. Undoubtedly there can be no question that these difficulties can be overcome by an apparatus of different design in which the two liquids in question pass each other in one shallow layer.

Pittsburgh, Pa.

The Use of Nozzles in Measuring Pulsating Flow

NOZZLES are one of the most valuable pieces of equipment in measuring the flow of fluids. Their application in the measuring of steady flow is well known and needs no further mention here.

When nozzles and some sort of measuring device for differential pressure are used for pulsating flow, errors result, unless the flow curve is known as a function of time. This fact is easily illustrated by reference to Fig. 1, A, which represents flow of fluid plotted against time. In this special case it is assumed that the velocity of flow fluctuates periodically and abruptly between the values of 10 ft. per second and zero. Evidently, the average velocity must equal 5 ft. per second. If, however, the velocity is measured by an instrument such as a nozzle, or a Venturi meter, or a Pitot tube in conjunction with a differential pressure gage, the instrument will not measure the average velocity directly, but its readings will fluctuate between 10² and 0²—i.e., the readings will fluctuate between 100 and 0. If now the gage be throttled down so that it can be read, then it will show the average between 100 and 0 or 50. However, the square root of 50 does not equal 5, but is a little more than 7, and the conclusion is that the instrument will show 7 ft. per second instead of the actual average velocity of 5 ft. per second. This in itself would do no harm if we knew beforehand how much the excess reading is, but, as before stated, to that end we must know the flow curve. Let the flow curve be as in Fig. 1, B, which again represents velocity of flow plotted against time, and let the velocity fluctuate now only between 6 ft. per second and 4 ft. per second, then the

readings of the instrument will fluctuate between 36 and 16, these being the squares of 6 and 4. The average between 36 and 16 equals 26 and the square root of 26 is but little more than 5, from which it can readily be seen that the error becomes quite small if the violence of the fluctuations of flow can be decreased or damped. Several means can be employed for accomplishing this result.

In the testing or in the regular supervision of the air delivery of reciprocating compressors it is quite possible to install a large tank between the compressor and the delivery line. This tank may well act as an after-cooler for removing the moisture from the air. If this

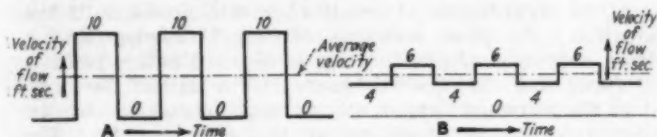


FIG. 1. FLOW CURVES WITH VELOCITY FLUCTUATING PERIODICALLY: A, OVER A WIDE RANGE; B, OVER A NARROW RANGE

tank be about three or four times the volume of the high-pressure cylinder, the flow fluctuations are greatly reduced, and if in addition a throttling flange be applied at the end of the tank—i.e., at the place where the tank joins the delivery pipe—then the flow in the delivery pipe will be made quite even and a nozzle or a similar instrument can be used with great accuracy. The larger the tank and the smaller the throttling flange the more uniform is the flow. The flange need not be so small as to produce any noticeable pressure drop.

The same method can also be used in the application of steam meters to measure the flow of steam for reciprocating engines. Every engine should be equipped with a large receiver separator, and can in addition be equipped with a throttle flange at the place where the steam main joins the receiver separator. The flow is made even enough to apply a steam meter and to accept its readings without any correction.

It has also been suggested that the flow in lines carrying variable velocity fluids can be made even for a distance by placing a fan in the line at either side of the nozzle or of the measuring instrument, the theory being that the fans have inertia and resist pulsating flow, thereby reducing the violence of the pulsations.

In the testing of air compressors and blowing engines, or of Roots blowers, the following methods for the ap-

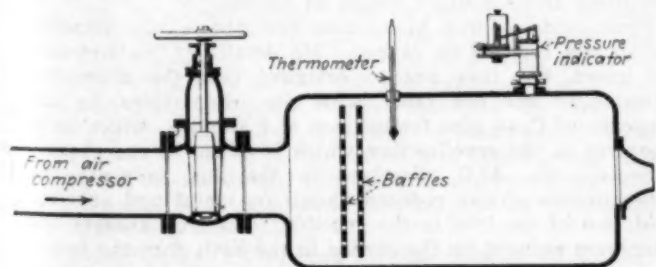


FIG. 2. USE OF NOZZLE IN DISCHARGE LINE OF COMPRESSOR

plication of nozzles have been found quite successful. As shown in Fig. 2, a valve may be placed in the discharge line from the air compressor or blowing engine, and a tank with the nozzle may be placed at the end of the line. The valve serves the purpose of varying the pressure against which the compressor discharges, and at the same time reduces the fluctuations of flow in

the tank. The fluctuations proper can be measured by indicator which is mounted on the tank, and the drum of the gage is pulled as evenly as possible by hand. The indicator gives at once the average pressure in the tank and the fluctuations of pressure. The diameter of the nozzle and the pressure of the air in the tank, together with its temperature, immediately give the quantity of air flowing. Any corrections for variations in velocity can be made as indicated in Fig. 1. The baffles are necessary for eliminating the effects of velocity of approach upon the nozzle and should consist of perforated plates or strong wire mesh.

For the ordinary run of shop compressors, it is usually preferable to test the compressor while it is in operation. This can be done by using nozzles on the inlet side, provided, of course, that the piston rod packings are tight. In this case it is quite easy to obtain uniform flow by attaching to the compressor inlet a sheet-iron box which carries the nozzle or nozzles, and which in addition is equipped with a rubber diaphragm as shown

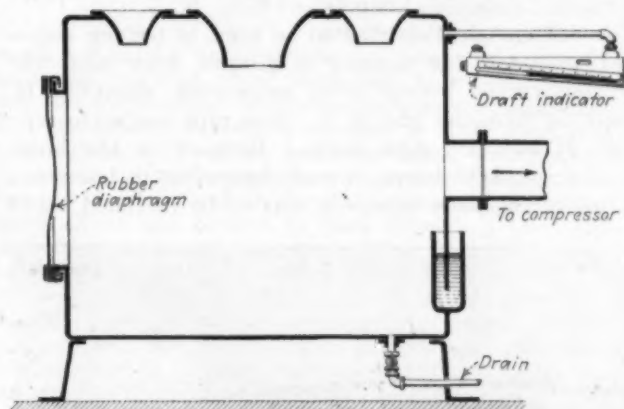


FIG. 3. USE OF NOZZLE ON INLET SIDE OF COMPRESSOR

in Fig. 3. The volume of the box acts as an equalizer and the rubber diaphragm which flops in and out helps materially to maintain an almost constant flow through the nozzles. A box of this sort is a very valuable adjunct to mechanical laboratories and especially in shops where air compressors are built or used, because it allows testing of the actual air compressor delivery with very little trouble. To this end, it is advisable to have several nozzles in the box and to plug up those which are not in use. It is very desirable to have a safety valve on the box to protect the rubber diaphragm from injury in case someone should close more nozzles than is good for the rubber.

Such a safety valve is indicated on the right hand side of the box in the shape of a U-tube full of water. The section of the U-tube must be large enough to prevent the formation of such a vacuum in the box as might break the rubber diaphragm. The pressure drop of the nozzles can be kept quite small, and can be measured by means of an inclined gage such as a draft gage. The pressure drop through the nozzles amounts to much less than the variations in barometric pressure and no fear need exist that the measuring box will in any way interfere with the air delivery of the compressor.

Nozzles have not been used for testing to the extent which they deserve, probably for the reason that it is troublesome and expensive, first, to lay out nozzles, and then to machine them. These obstacles, however, were removed some time ago by the Bacharach Industrial Instrument Co., of Pittsburgh, which has standard nozzles

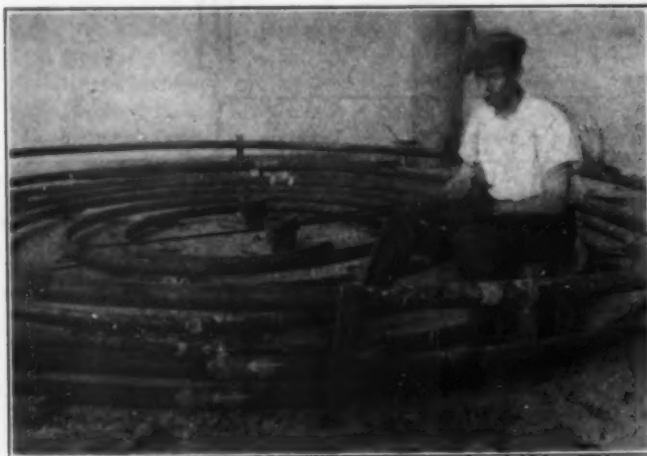
for almost all purposes of testing. It may therefore be hoped that nozzles will be used more in the future for the testing of reciprocating machinery. It may also be stated that the discharge from positive blowers, such as the Roots or Connersville blowers, is likewise pulsating and needs some means to reduce the fluctuations.

Occasionally, it is practically impossible to damp the vibrations on account of the size of the equipment—for instance at the air inlet of blast furnace blowing engines. In that case the flow velocity curve can be determined occasionally by placing in the nozzle a very light flapper and by recording its motion on an indicator. In the use of such an instrument it is frequently found that, during very short intervals, the air actually blows back.

Welding Curved Pipe Coils of a Glucose Tank

As the result of an unforeseen circumstance a thermit pipe-welding job of unusual nature was recently performed on a helical 24-in. standard pipe coil for the American Chiclé Co., Long Island City, N. Y.

The coil in question was to be used to convey steam under pressure for heating a glucose tank and was first constructed in one piece measuring about 17 ft. in outside diameter and 14 in. from pipe center to pipe center of adjacent pipe turns. Because of the large size of the coil, however, it was impossible to transport the coil to the place where it was to be installed, so it



THERMIT WELDED CURVED PIPE COIL

was necessary to cut the coil with an oxyacetylene torch into two semi-circular segments by making nine cuts and later thermit welding these cuts together.

As the cutting torch had left ragged edges, the pipe ends first had to be backsawed. The surfaces to be welded were next faced smooth with a pipe-facing machine and the usual pipe-welding operations then followed. Immediately after each weld was made the section having one end just welded and the other end about to be welded was bent around to a shorter radius and into a proper position for the next weld, the red hot temperature of the weld just made enabling this bending to be made.

The results of the welding were entirely satisfactory in every way, continuous joints being obtained with no trace of leakage whatsoever during a preliminary test of the welded coils under 40-lb. steam pressure and later in service under a 5-lb. pressure intermittently for about 2 months up to the time of writing.

The work was undertaken for the American Chiclé Co. by the Carrier Engineering Corp., Newark, N. J.

Synopsis of Recent Chemical & Metallurgical Literature

The Formation of Pearlite in Steel.—In a paper on this subject read before the Cleveland (England) Institution of Engineers, and abstracted in *Iron and Coal Trade Review*, Dec. 9, 1921, J. H. Whiteley showed that pearlite can grow directly from a solid solution of carbide of iron in gamma iron without the formation of any intermediate stages, and that the so-called transition stages, troostite and sorbite, should be regarded as alternative or side products of the transition. He gave evidences of "lag," showing that a certain degree of supersaturation is required before pearlite will form, and that growth never starts within the area, but at the boundary, apparently through inoculation by the adjacent ferrite or cementite, as the case may be. The average coarseness of the pearlite was not found to depend either upon the length of heating or maximum temperature, but simply upon the rate of cooling through Ar₁. This was explained as due to the greater opportunity allowed, in slow cooling, for solution and diffusion of the carbide to occur whereby the spacings are widened. The maximum width of ferrite laminae yet seen is slowly cooled hypo-

eutectoid steel is $\frac{1}{22,000}$ in. With a given rate of cooling,

the presence of manganese and silicon in steel increases the fineness of the pearlite, and pearlite formed in the presence of free cementite is much coarser than that formed either in eutectoid or hypo-eutectoid steels. Apparently this effect is due to the manner of inoculation.

Standard and Tentative Methods of Sampling and Testing Highway Materials.*—This publication gives in full the methods recommended by the second conference of state highway testing engineers and chemists as adopted at their meeting in Washington early in 1920. Many of the methods are those of the A.S.T.M. Most of the others are those which have previously been recommended by the bulletins of the U. S. Department of Agriculture Bureau of Public Roads. The bulletin includes more than fifty methods of testing or analysis for both non-bituminous and bituminous road materials, including stone, sand, cement, brick, bituminous products, etc. Full recommendations are included of standard methods for sampling each of the important materials.

Production of Iron by Direct Electrothermic Reduction of the Ore. (Levoz Process).—Marcel Guedras in *Technique moderne*, vol. 13, p. 264, (1921) describes the Levoz process. Essentially it consists in the formation of ferro-alloys in a reaction mass, which later purify iron oxide. The process comprises three distinct stages as follows:

First, oxides of iron, manganese and other easily reducible metals are reduced by carbon. No details of the furnaces are given, but they are so designed that the aluminum silicates of the ore react with the iron oxides, in the presence of C, to give ferrosilicon and alumina, which later dissolves in the cryolite flux which is added to the charge.

Second, the Al₂O₃ dissolved in the flux prevents the volatilization of any reduced aluminum metal and also the oxidation of the iron in the crucible. The iron absorbs the aluminum reduced by the carbon in the bath, forming ferro-aluminum and eliminating at the same time any iron carbide which has formed. With the ferrosilicon formed in the first stage the Al forms an Fe:Si:Al alloy, which is a powerful reducer and which gives rise to strongly exothermic reactions. At the end of the second stage the mass consists of a layer of slag over this complex ferro-alloy dissolved in iron and manganese.

Third, the molten mass flows into an electric furnace containing a charge of the ore to be reduced. The strongly reducing, complex ferro-alloy reacts with the oxides in the

*Bulletin 949, Department of Agriculture.

ore with great evolution of heat, so that the greater part of the heat absorbed in the two stages above is recovered and the current consumption in the third stage is very small. The slag, consisting of double silicates and of cryolite, has a very low melting point and is easily separated from the metal. The silicon, manganese, aluminum and calcium in the complex alloy first produced carry the metallic oxides and sulphides completely from the ore into the slag with formation of very fluid silicates. There remains a pure iron which may be either drawn off as such or converted into steel. The cryolite reacts with the lime of the charge to form CaF_2 and $\text{Al}_2\text{O}_3\cdot\text{Na}_2$; but this does not interfere with the main reactions.

The first step of the process is carried out in a reduction furnace with an inclined hearth, emptying into a crucible for the second stage and an electric furnace for the third, the molten metal flowing from one to the next by gravity.

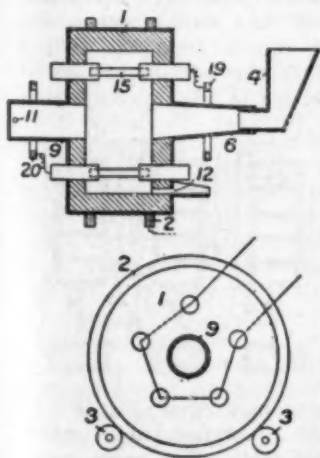
Advantages of the process are said to be: Any kind of ore can be treated. The cost of the plant is much less than that of a blast furnace, and the product obtained is pure iron or steel. There is an important saving in fuel. Reducing gases having a high caloric value are utilized. By suitable combination of furnaces, any grade of iron or steel can be obtained. The consumption of electric energy is reduced to a minimum owing to the strongly exothermic reactions of the aluminum alloys in the third stage. Finally, cost of labor is low.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Electric Furnace for Continuous Conversion of Zinc Dust Into Molten Zinc. An electric furnace for the continuous conversion of zinc dust into molten zinc comprises a cylindrical casing 1 surrounded by rings 2 which run on rotating rollers 3 whereby the furnace is given a rotary motion. A coned inlet tube 6 is fitted axially in one end of the furnace and zinc dust is fed into this tube from a hopper 4. A tube 9 is similarly fitted axially at the other end of the furnace and is provided with a number of adjustable openings 11 through which the residue escapes and by which the working of the furnace may be controlled. The molten zinc may be tapped off through an opening 12 in the furnace casing. The resistance members 15 are arranged concentrically round the axis of the furnace and

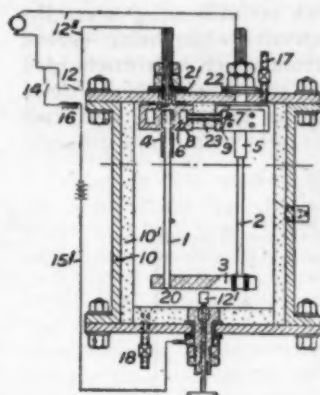


are coupled up, as shown, and fed with current from contact rings 19, 20. (Br. Pat. 168,018. C. E. Cornelius, Stockholm. Oct. 12, 1921.)

Purifying Gases. A process for the removal of sulphur compounds from coal or like gas consists in washing the gas with both a volatile oil such as benzene and a stripping oil such as creosote of which not less than 500 gal. are used per million cubic feet of gas. These oils may be mixed or used separately. Paraffin oil may be used instead of creosote, particularly if finely divided alumina or charcoal be suspended in it, and the stripping oil free from benzene may be introduced into the washer and benzene vapor added to the gas entering the washer. Thiophene may be removed by treatment with sulphuric acid and the benzene and creosote used again in a cyclic process. (Br. Pat. 168,482.

South Metropolitan Gas Co., E. V. Evans, H. Hollings and H. Stainer, London. Oct. 26, 1921.)

Refining Tungsten.—A process for the manufacture of ductile rods from high-fusing metals such as tungsten, molybdenum, etc., or alloys of the same consists in heating rods made of the said substances hung vertically in a vessel containing neutral or reducing gas at high pressure by the passage of an electric current or by an electric furnace,



bringing them to a nearly molten state and then using the elongation of the rods to stop automatically the heating current supplied to the rods or furnace. Two rods of tungsten 1 and 2 are placed vertically in a vessel 10 lined with refractory material 10' having openings 17 and 18 provided with cocks for the inlet and outlet of the inert gas, the lower ends 20 of the rods 1, 2 being connected by a horizontal tungsten rod 3. The upper ends of the rods fit into two electrodes 4, 5 which are fixed to two other electrodes 8, 9 having water jackets 6, 7 joined by a pipe 23 of insulating material, these electrodes 8, 9 being insulated from one another and the vessel 10 by insulating-pieces 21, 22. The heating current is supplied to these electrodes 8, 9 through lines 12 of low resistance upon closing a switch 12, and the elongation of the rods 1 and 2 causes contact between the rod 3 and an adjustable insulated electrode 12' which allows the current to pass through a local circuit comprising a low-resistance line 15, a switch 14 normally closed, and a trip coil 16 which then opens the main switch 12. When the rods are heated by an electric furnace, the elongation of the rods make contact as before to close a local circuit which may operate means to cut off the main heating current. If the material of the rods contains impurities, the rods may be heated initially under a reduced pressure to eliminate the impurities by vaporization and later the high pressure applied. (Br. Pat. 168,697. E. Aoyagi, Kyoto, Japan. Oct. 26, 1921.)

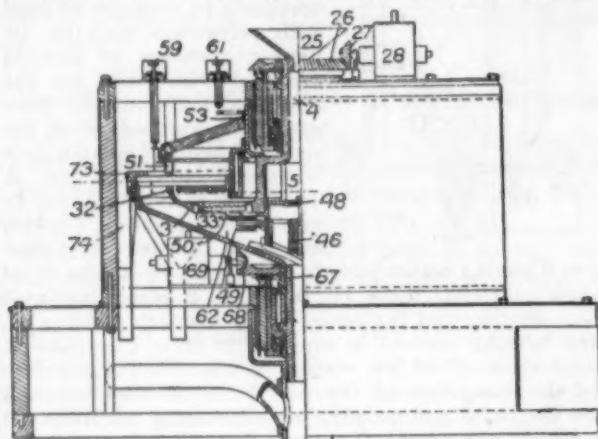
Froth-Flotation Process for the Concentration of Oxidized Ores. In a froth-flotation process for the concentration of oxidized ores such as cassiterite, or oxidized ores of tungsten, lead, zinc, or copper, carbon dioxide or a gas containing it is introduced into the pulp as a gangue-modifying agent. A mineral-frothing agent may be used consisting of or containing a fatty acid or a fatty-acid compound such as soap. The carbon dioxide or gas containing it may constitute both the gangue-modifying agent and the flotation agent. (Br. Pat. 168,098. L. A. Wood and Minerals Separation, Ltd., London, Oct. 12, 1921.)

Glycerine.—In a process for treating waste liquors of alcoholic fermentation for the extraction of glycerine, the liquors are neutralized with lime or chalk, filtered and boiled with ferric chloride, preferably under pressure, until the liquor no longer reacts with Fehling's solution. The iron is precipitated by lime, and then the lime by carbonic acid or sodium carbonate. The resulting liquor is filtered, concentrated and distilled. In a modification, ferric sulphate is used instead of ferric chloride, the iron being then precipitated by baryta instead of lime. (Br. Pat. 168,833 Barbet et Fils et Cie., Paris. Nov. 2, 1921.)

Purifying Tannins.—Tannins, preferably those extracted from the raw materials with the aid of acids, are purified by conversion, by the action of bases or basic compounds, into insoluble or difficultly soluble salts which are freed from impurities by washing with water or organic solvents and then decomposed by acids or in some cases by salts; the tannin solution is finally evaporated. As basic compounds may be used magnesium oxide, hydroxide or carbonate, or the corresponding barium, strontium or calcium compounds and two or more bases may be used successively or conjointly. For the decomposition of the tannin compounds, acids or salts which will give insoluble compounds

with the base or bases employed are preferably used. The crude tannins may be previously treated with reducing agents, such as sulphurous acid, hydrosulphurous acid or "other acids of sulphur," but preferably with volatile reducing acids. (Br. Pat. 169,722; not yet accepted. Byk-Guldenwerke Chemische Fabrik Akt. Ges., Berlin. Nov. 16, 1921.)

Electrostatic Separators. In the electrostatic separation of finely divided material such as metal-bearing ores, the material is dried by heating elements while being spread centrifugally in a rotating pan, from which it is discharged into an electrostatic field wherein the susceptible particles are sustained against gravity so as to become separated from the less susceptible particles, which fall to a different



point of discharge. Apparatus for effecting such a separation comprises a pan 3 the rim 32 of which forms one electrode, a second annular electrode 51 being situated above the rim of the pan and the whole being rotated along with the hollow shaft 4 by a motor 28 through gearing 26, 27. The material to be separated passes down the hollow shaft 4 from the hopper 25 into the pan 3 through a chamber 5 and is dried by heating elements 33 in the bottom of the pan. The particles are cast centrifugally against the rim electrode 32 and the susceptible particles are carried upwards in their centrifugal travel through the electrostatic field over the edge of a dividing-ring 73 and into hoppers 74. The less susceptible particles falling on the inside of the ring 73 into the hopper 62, which may be given an opposite rotation through gearing 67, 68, pass down the shaft 4 to waste or, if a further separation is desired, to the next pan of a series. In the hopper 69, a transformer 49 may be provided to supply a spark at gaps 50 for preventing the dispersion of dust, and a bypass valve 48 operated by a solenoid 46 may be provided in the shaft for cutting-out steps in the separation where a series of separators are used. Low-tension current is conducted to the heating elements 33, transformer 49 and solenoid 46 through a brush 61 and ring 53, and the high-tension supply to the annular electrode 51 is through a brush 59. (Br. Pat. 168,479. G. R. Brown, Bondi, near Sydney, New South Wales. Oct. 19, 1921.)

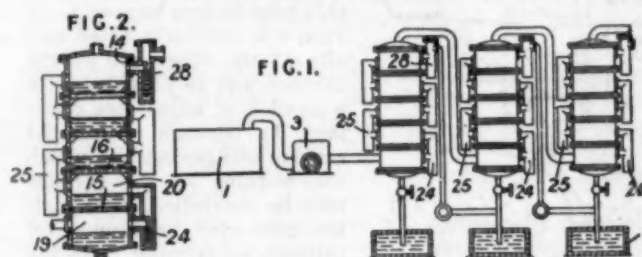
Hardening Oils.—Unsaturated oils are catalytically hydrogenated by treatment with a material which is capable both of giving off hydrogen and of acting as a catalyst. This material is prepared by melting together certain metals, such as iron, manganese, ferromanganese, copper, tin, zinc, lead, aluminum, antimony, nickel, cobalt and bismuth, to form an alloy which is stated to evolve hydrogen when added to the oil alone or to oil containing water. The particular alloy mentioned as an example is composed of ferromanganese, aluminum, antimony, nickel and lead in stated proportions. (Br. Pat. 169,147; not yet accepted. W. P. Heskett, Waiotahi Creek, Thames, New Zealand. Nov. 2, 1921.)

Synthetic Resins.—Phenol or its homologs when condensed with acetaldehyde or its polymers produces a resin which is soluble and does not harden on heating. Formaldehyde or its polymers may be added at any stage of the

process to render the product less soluble or insoluble or to make it harden. Acids, bases and salts may be used as accelerators, the following being mentioned as suitable: sulphuric acid ammonia, caustic alkali, oxalic acid and phenyl hydrazine hydrochloride. (Br. Pat. 169,347. H. V. Potter and W. F. Fleet, Birmingham, and Dainard Lacquer Co., Ltd., Westminster. Nov. 9, 1921.)

Treating Hides and Skins.—Comprises a process for depilating hides and skins in which extrinsic bacteriological or saprophytic enzymes are inactivated while the action of thrombase (thrombin) which is stated to be found in the skins, especially at the roots of the hairs, is encouraged or activated. The extrinsic enzyme system, to which the term "saproprotease" is applied, is inactivated by the use of end products of proteoclastic enzyme action such as ammonia or compounds producing ammonia, amino acids, skatol and indol. The intrinsic enzyme, thrombase, is activated by the addition of easily dissociated calcium salts or compounds such as the lactate or polysulphides thereof. The activator and inactivator are mixed together in the form of a solution, the inactivator preferably comprising a 1 per cent solution of ammonium hydrate. The action of the intrinsic enzyme may be assisted by the addition of trypsin or other proteolytic enzymes which will work in an alkaline medium. The depilation is stated to be effected without destroying the epidermis, so that comparatively large sections thereof with the hair attached can be removed. Subsequent bating is unnecessary. In preparing dressing leathers, the solutions are heated, while for sole leathers cold liquids are employed, these allowing imbibition or plumping to take place to a greater extent. The process may be employed in the treatment of diseases, but no claim is made for this application of the invention. The provisional specification describes also the use, to assist the depilatory action, of pepsase and in certain circumstances of the saprophytic extrinsic enzyme which is therein termed "saprophase." (Br. Pat. 169,730. H. C. Ross and Walker & Sons, Ltd., Bolton. Nov. 23, 1921.)

Methylamine.—Gases or vapors are minutely subdivided in passing through a series of porous diaphragms and layers of liquid thereon in order to effect their maximum contact with liquids. The process may be applied to the treatment of gases from petroleum stills, coke ovens and gas producers, with liquids which may contain substances in suspension. The gases and vapors from the still 1 pass through the compressor 3 to the bottom of one of a series of diffusers shown in section in Fig. 2, comprising



a shell 14 containing gas-porous diaphragms 15, 16 . . . which form compartments 19, 20 . . . connected in series by ducts 24, 25 . . . having liquid seals. The gases penetrate upward through the successive diaphragms and the liquid borne thereon, which enters at the inlet 28 and to the extent limited by the height of the duct inlets flows in counter current. The gases are led to the bottom of the next diffuser, from which liquid may be pumped to the previous one, or the liquid may be discharged from each diffuser into separate tanks. (Br. Pat. 169,605. Canadian American Finance & Trading Co., Ltd., Victoria, B. C., Canada. Nov. 16, 1921.)

Wood and Like Cellulose Pulp and Fibers.—In the preparation of light-colored strong fibrous material for the paper trade from wood or other substance containing cellulose, in logs or billets, the material is saturated, softened or boiled with water in vacuum or under mechanically produced water, air or steam pressure. Either a high temperature

of 105 to 120 deg. C., or a low temperature of about 80 deg. C. and a high pressure of from 5 to 10 atmospheres or a low pressure of about 350 mm. of mercury may be employed. Neutral, acid or alkali reagents may be added to the water. A flowing movement of the liquid used is maintained in the direction parallel to the direction of the fibers of the wood. When treating under vacuum, an air pump is used during the whole operation, lasting 6 to 8 hours, the drop in temperature being made up by indirect heating. (Br. Pat. 169,802. L. Enge, Niederschreiberau, Silesia, Nov. 23, 1921.)

Book Reviews

THE MANHOOD OF HUMANITY. THE SCIENCE AND ART OF HUMAN ENGINEERING. By Alfred Korzybski. Pp. 264. New York: E. P. Dutton & Co. Price \$3.

Here is a book which we believe would have delighted the heart of the late William James. It is easy to read, and no one need fear that he will go to sleep over it. It isn't dull, or involved, or even subtle. If a reader tries to be subtle in reading he will miss its bigness.

Early in the work the question is asked, What is man? The answer given is full of illumination. We know life, the author says, in three phases, as plant, as animal, and as man. The plant is a chemical phenomenon. The animal is also a chemical phenomenon, but it has another dimension. It controls, or "binds," as Count Korzybski says, space. The author means space on or about the earth, space of three linear dimensions; the space in the fields, in the woods, among houses and along the road; space without any cosmic complexities. The animal goes or walks or flies whither it will, which the plant does not do. If your metaphysical conscience urges you to protest against the postulate of will in animals, then substitute desire or any other word that will indicate the quality that we know does exist. The plant is a chemical phenomenon. The animal is a chemical phenomenon, but it also binds space. Man has both these attributes; he is a chemical phenomenon, he binds space, but to him is added a third dimension which makes him a different being from animals. He has control over and "binds," as the author says, time. Man binds time. No plant or animal does this. By time we mean that which is ticked off by the clock, and is measured by seconds and minutes and hours and years and centuries. Please do not try to get off the earth in regard to time or space, even in imagination, when you read this book.

The difference between an animal and man as timebinder is immense. The beaver, for instance, builds his dam according to his instinct and in the same way that beaver dams have been built for hundreds of thousands of years. Each generation builds for itself, and does not learn from the past. When man builds a house he uses not only his instinct for protection against the weather; he avails himself also of the experience, the work and the inventions of the dead, adding to this his own inventions, and thus makes a house different from that of former generations. He has the capacity to improve on earlier houses. Plumbing, elevators, electric annunciators and the like are incidents of invention added originally by living men to the inventions of men who were dead.

Let us cite a couple of examples in which the time-binding faculties of man have been actively employed, and observe what progress follows. In the past 125 years great advances have been made in the mechanic arts. They have been no less than amazing. The reason for this is that through patent records and by the increased means of communication which inventions have brought about man has been informed of the experiences of previous generations, has learned the particulars of the work of the dead, and has added his own inventions to these. A similar curve of progress has taken place in the natural sciences

during the past 60 or 75 years. Discovery leads to discovery. In no other walk of life is there so complete a historical perspective available as in the natural sciences and in the mechanic arts. This progress has been due to the fact that when he so wills, man—and man alone—can make of the past, the present and the future one continuous now.

Consider the progress in other respects and we find no such curves. The reason is that we have tried to organize continuance by tradition without the aid of experience on the one hand, or we have become so offended by tradition that we have vainly tried to organize methods of human behavior out of our own puny, ignorant, narrow, unenlightened imagination. We have blundered about as we do, for instance, in matters of government, like little children with no one to guide them.

Let's say that man as a time-binding creature is old as we count a lifetime, but young on earth. He has grown some, but how much has he grown as an intelligent being, say since the days of Babylon? The sandy desert which is Babylon today is scarcely an improvement over the city of hanging gardens that was. We get ahead in one respect and go back in another. The lusty artisan of Renaissance days, singing as he worked, making things of a quality of beauty that we cannot reach, surely had a more abundant life than the factory hand of today, whether he could read and write or not. He had the joy of artistic creation, which is a delectable state, unknown to most of us.

We have, by means of engineering, been diligent in conserving materials to the best uses, and in avoiding wastes of them, but we have been neglectful in conserving humanity. We look after man's health somewhat as we look after the health of animals, but we have not looked after man as a time-binder. And he is that. Not one of us can loosen himself from this line of time. We can't get rid of our participation in it. Then let's follow the author again and note again what we can do in this respect.

Time proceeds in arithmetical progression as it is ticked off by the clock, or is measured by the years. Man as a time-binder can progress according to a different ratio. The first of a series of generations, for instance, has its experiences, meets its difficulties and solves its problems by invention. The second has the advantage of the experience and work of the first, and to it adds its own experience. The third adds to this, and so on, so that the line of progress of time-binding man may be geometric rather than arithmetical. The lofty heights of understanding, of intelligence, of welfare in the arts of living, to which humanity may attain, are stupendous. It is a problem, as Mr. Korzybski puts it, of engineering. He has worked out a mathematical formula which is the first step in showing the available rate of progress, and this is a practical rule. As soon as we begin to compute human progress by means of mathematics we shall begin to know our shortcomings. We need to integrate our work in relation to the general welfare. The book is full of hints in this direction.

Here's another point of attack. No man ever "makes" a fortune. He collects it. Thousands and thousands of dead have contributed to it. The wealth of the world is in the main a great treasury left by the dead. Our business is to carry it on. Anyone who destroys such results by misuse of it is not living the life of a human being; he is living the life of a ghoul. He is preying upon the dead, and neither legalistic title nor documentary ownership alters the fact. Everyone is a time-binder. Everyone is passing on the work of the past to the future. What are we doing with it?

We have claimed that man is a highly developed animal. He has many of the organs and the space-binding qualities of an animal, but he is not any more an animal than a cube is a plane because it has planes as parts of its structure. Then we have said that man is part animal and part something supernatural. That means that he is part something that we can understand and part something that we cannot understand. It is dodging the question and does not lead to progress. It is a lazy thought and irreverent to whatever Greater Intelligence there may be beyond our senses. Our business in life is living, and we should make the best of it.

ELLWOOD HENDRICK.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Proposed Merger of Fertilizer Companies Expected to Materialize Next Spring

Consolidation plans are under way among about thirty-five independent companies manufacturing commercial fertilizers for a merger of interests. A meeting will be held early in January, it is stated, to perfect details of the proposal, and it is expected that definite plans will be developed to bring about the change in the spring. The move is being made on the basis of business economy, with idea of concentrating operations at certain plants, operating under full capacity, and shutting down other works until conditions in the industry warrant resumption. Among the companies interested in the movement are the Davison Chemical Co., Piedmont-Mt. Airy Guano Co. and G. Ober & Sons Co., all of which operate plants in the Baltimore, Md., district.

Registration of Professional Engineers in West Virginia

Pursuant to Chapter 106, acts of the Legislature of 1921, it will be unlawful to use the title of "Registered Professional Engineer" in West Virginia unless actually registered with the State Board of Registration for Engineers, Charleston, W. Va. The official roster will include civil, structural, mechanical, electrical, mining, metallurgical and chemical engineers.

Registration is not compulsory except for those desiring to use the title. The initial fee is \$20 and the yearly renewal fee \$10. Application blanks may be obtained from George E. Taylor, Secretary, 504 Coyle & Richardson Building, Charleston, W. Va.

Fertilizer Manufacturers Want Pyrites and Crude Oil Kept on Free List

Formal requests have been made of the Senate Finance Committee by the National Fertilizer Association that pyrites and crude oil be left on the free list. The committee's attention has been called particularly to the conclusion of the United States Tariff Commission that the serious competition which domestic pyrites producers face comes from American sulphur rather than from imported pyrites.

In this connection it is pointed out to the committee that prior to the war approximately a million tons of foreign pyrites was imported annually for use in sulphuric acid manufacture. During the war foreign pyrites was supplanted largely by domestic sulphur as the raw material for sulphuric acid. As a result of the war there has been a large increase in sulphur production. The price of sulphur has declined to the point where foreign pyrites no longer can compete with it, it was argued, except at points highly favored in the matter of transportation, such as Atlantic ports. It is claimed that even under the stimulus of war prices the production of domestic pyrites remains small. A tariff on pyrites would have the effect of prohibiting further importations, but it is contended that sulphur and not domestic pyrites would be substituted unless sulphur producers, because of the tariff, greatly advanced their prices. With sulphur at its present price, it is pointed out, the consumption of foreign pyrites has fallen to less than a quarter of the pre-war tonnage.

The point is also made that a tariff on pyrites would be a standing invitation and a constant temptation to the sulphur producers to add the amount of the duty to the price of their products. That the domestic sulphur industry needs no protection is apparent, it is pointed out, by the fact that it has displaced the Sicilian product in the im-

portant Scandinavian markets and is being sold extensively in England, France, Germany and Africa.

With regard to fuel oil, C. H. MacDowell, president of the National Fertilizer Association, in a statement submitted to the committee, among other things says:

The National Fertilizer Association regards with apprehension the announced purpose of representatives of certain oil-producing companies to urge a tariff duty on imports of crude oil. We had believed that question was settled definitely some months ago when the House of Representatives, in response to the overwhelming sentiment of the country, as affirmed in a letter from the President, rejected the recommendation of the Ways and Means Committee for a duty and voted to retain oil on the free list. To learn now that efforts for a duty will be renewed and to hear that such efforts are receiving some support in the Finance Committee is very disquieting.

The fertilizer industry, struggling out of a period of unparalleled depression, is in no position to bear the burden of a tariff on oil. The losses of the past season, due to a decline of about 50 per cent in the use of fertilizer, were not confined to fertilizer manufacturers. There followed reduced yields of field crops, causing tremendous losses to farmers and business generally. C. R. Capps, vice-president of the Seaboard Air Line Railway, testified at the hearing before the Interstate Commerce Commission Dec. 16 that the loss of fertilizer tonnage to the railroads of the South this year amounted to more than 2,000,000 tons. To that primary loss must be added the potential crop tonnage which such a quantity of fertilizer develops.

Many of the large fertilizer plants on the Atlantic seaboard use Mexican crude for fuel. In addition practically all the power used in the mining of phosphate rock is produced from plants using Mexican crude oil for fuel. It is contended that a tariff on crude oil would increase greatly the cost of fertilizer without bringing any corresponding benefits to domestic oil producers.

Shipment of Steel by Barges on Inland Waterways System

Considerable interest is being taken by communities along the Ohio and Mississippi rivers in the possibility of using the inland waterways system of the country for handling steel trade in quantities. This has been greatly quickened by the success of the Jones & Laughlin Steel Co., of Pittsburgh, which has already sent two large fleets of barges carrying approximately 400 carloads of steel products south on the Ohio and Mississippi from its works in the Pittsburgh district, and is preparing to continue the service as a regular factor in its distribution system.

The first tow, carrying about 100 freight carloads, left the Pittsburgh harbor the last week in October, and distributed its cargo to Huntington, Louisville, Evansville and St. Louis. The second tow, three times as large as the first, carrying 300 freight carloads of steel products, started down the river the first of December, proceeding as far as Memphis, unloading parts of its cargo at several intermediate points.

Not only is the steel company planning an increase in use of the inland waterways system, but has advised some of its customers in Memphis and other points that it is looking into the possibility of the use of seagoing steel barges for delivery of steel products to such points and, in time, to the ports on the Pacific Coast by way of the Panama Canal.

F. E. Hackett, general manager of sales of the Jones & Laughlin Co., is responsible for the inauguration of this new service.

More Plants in Many Lines of Industry Increasing Operations

Paper—The French Paper Co., Niles, Mich., is operating its local mills at full capacity. A number of improvements are being made at the plant.

The American Writing Paper Co., Manchester, Conn., has resumed production at its local Oakland mill, following a shutdown for about a year past. All former operatives have been engaged and full-time production schedule has been adopted.

The Consolidated Paper Co., Milwaukee, Wis., has resumed full-time operations at its Wisconsin Rapids and Biron mills. The plants have been running on part time for some months past.

Ceramics—The H. E. Buck Manufacturing Co., Lake Charles, La., will take possession of its local plant, effective Jan. 1, heretofore operated under lease by other interests. It is proposed to resume full operations at once for the manufacture of building brick.

Potteries devoted to the manufacture of dinnerware in the eastern Ohio district are now operating in excess of 80 per cent capacity. Production is greater than at any time during the past year. Electrical porcelain potteries are producing under a full-time schedule at capacity output.

Glass—The Sneath Glass Co., Hartford City, Ind., is maintaining active production at its plant, and has distributed a bonus of \$10,000 among its employees.

Oil—The Standard Oil Co. has resumed operations at its Bayway refinery, Elizabeth, N. J., after a curtailment for about 8 months past. Employment will be given to about 500 operatives. Effective Jan. 1, the 4,000 employees at the Bayonne refinery went on full time, as compared with 5 and 5½ days previously.

Rubber—The General Tire & Rubber Co. is increasing production at its plant at Akron, Ohio. Plans are being considered for doubling the present capacity during 1922.

Effective Jan. 1, the Mason Tire & Rubber Co., Kent, Ohio, has increased production from 2,300 casings a day to 4,500 casings. The plant is working on three shifts and giving employment to about 1,000 persons. This number will be increased by approximately 700 additional operatives at an early date.

Copper—The Utah Copper Co., Bingham, near Salt Lake City, Utah, is planning for the resumption of operations at its plant at an early date, probably in February, giving employment to more than 2,500 men.

Metals—The silver and lead producers in Utah and Idaho are increasing operations. During the last week in December three additional silver-lead furnaces were blown in, and others will start up at an early date.

Iron and Steel—The Lackawanna Steel Co., Buffalo, N. Y., is maintaining a production about 50 per cent of normal, and is said to be planning for an early increase.

The Bethlehem Steel Co. has continued the operation of its coke ovens and blast furnaces at the Steelton, Pa., works throughout the holiday period. Departments closed down during this time to permit repairs and improvements to machinery will resume production at once.

The Colorado Fuel & Iron Co. has arranged for the immediate resumption of operations at its steel mills at Pueblo, Col., on a 50 per cent basis, giving employment to about 2,000 men. The company recently reopened its iron mines on a 40 per cent production schedule.

The Carnegie Steel Co. is operating two blast furnaces at its Mingo Junction plant, near Steubenville, Ohio, with blooming, bar and other mills recently placed in service. A large number of men are being employed who have been idle for many months past.

Magnesia—The Keasbey & Mattison Co., Ambler, Pa., is arranging for the early resumption of operations at its local plant, closed for some time past. Initial production will be on a 5-day, full-time, day-and-night-shift basis.

Kelp Plant May Be Sold

The Bureau of Soils has informed the appropriations committees that negotiations are pending for the sale of its kelp plant at Summerland, Ca. While the sale has not been consummated, the opinion is expressed that the plant will be disposed of during the current fiscal year.

Vulcanization of Rubber Discussed at Meeting of Delaware Section, A.C.S.

Dr. H. L. Fisher, chemical director of the B. F. Goodrich Co., addressed the Delaware Section of the American Chemical Society on Wednesday evening, Dec. 21. His subject was "Rubber Chemistry, Particularly Vulcanization and Its Acceleration," and the lecture was illustrated with slides and experiments. The sources of crude rubber were described and statistics as to the production and consumption of rubber were presented, showing that, of the world's total production, 76 per cent goes into tires and tubes; 67 per cent is imported into the United States and 50 per cent goes to Akron, Ohio.

The work on the structure of the rubber molecule was reviewed briefly and the speaker stated that the consensus at present favors the structure $(-\text{CH}_2-\text{C}(\text{CH}_3)=\text{CH}-\text{CH}_2-)_n$. It is believed that an indeterminate number of these chains are polymerized to form complex rings, with one double bond for every five carbon atoms.

The process of vulcanization is essentially the addition of sulphur to the rubber molecule, but the mechanics of the reaction are not thoroughly understood. In the hot process, sulphur is mixed with the rubber and heated to a temperature of 135 to 150 deg. C. In the cold process, the rubber is treated with a dilute solution of sulphur monochloride in some organic solvent, such as benzene. In the recent Peachey process, the rubber is treated with a mixture of sulphur dioxide and hydrogen sulphide at the ordinary temperature. In any case the amount of sulphur added is determined by the use to which the product is to be put. It is possible to add as much as 32 per cent of sulphur, corresponding to one atom of sulphur for each double bond in the rubber molecule. Ordinarily not more than 6 to 7 per cent of sulphur is added. The vulcanization process is still controlled by rule-of-thumb methods.

It has been known for many years that the use of such inorganic materials as litharge, magnesia, slaked lime and certain iodides would hasten the reaction between sulphur and rubber. In 1906 A. H. Marks used aniline and thiocarbonyl in vulcanization, and since 1910 many other organic accelerators have been introduced. One reason for this has been the development of synthetic rubber, which is much more difficult to vulcanize than the natural product. Among the many accelerators used may be mentioned pyridine, hexamethylenetetramine, p-nitrosodimethylaniline, dithiocarbamates, zinc xanthate and other basic compounds. Any acidity, even that of phenols, is harmful. The action of these accelerators is not well understood. They apparently act as sulphur carriers, and as such they may be considered as catalysts.

Sugar Refining Studied by Chemistry Students of University of Texas

Students of the senior class of the chemistry department of the University of Texas, Austin, are giving concerted attention to sugar refinery operations as found in regular plant practice. Weekly visits are being made to the plant of the Imperial Sugar Co., Sugarland, Tex., for investigation work, and reports are made after each trip covering the situation as found. Two students make the trip each week and expenses are defrayed by the state; in this way practically the entire class will be enabled to gain the practical experience thus afforded. Special experiments are being made to determine the best methods for saving sugar cane from early fermentation, and to eliminate damage from the cane borer. The sugar is analyzed carefully and the various properties are studied by the students, and the industry is considered, as well, from other standpoints. Reports on the findings are made to the state.

Census of Coal-Tar Chemicals Extended to Include Other Organic Chemicals

The United States Tariff Commission has extended its census of coal-tar products to other organic chemicals, including the aliphatic group. The Synthetic Organic Chemical Manufacturers Association was instrumental in convincing the commission that the compilation of production figures of other organic chemicals would be particularly serviceable at this time.

Portland Cement Production Rate Decreases During November

The production of portland cement continued on a large scale during November, approximately 8,921,000 bbl. of finished cement having been manufactured. This quantity represents a decrease of 1,585,000 bbl. as compared with the record production of October, 1921, but is larger than that for any other month of this year up to May and is about 17 per cent greater than the average for November, 1917-1921. The total production for the 11 months ended Nov. 30, or 91,734,000 bbl., was about 99.5 per cent of the record quantity made during the corresponding period of 1920 and was 11 per cent greater than the average for the first 11 months of the years 1917-1921. Favorable operating conditions are indicated by this large production, the decrease having been due mainly to the slowing up of orders during the month.

The statistics shown in the following table, prepared under the direction of Ernest F. Burchard, of the United States Geological Survey, are based mainly on reports from producers of portland cement and in part on estimates. They indicate that even though the output for December should not quite equal that for November, the totals for 1921 would come very close to those for 1920 and thus constitute one of the highest outputs on record.

PORTLAND CEMENT STATISTICS, FIRST 11 MONTHS, 1921

Month	Production Bbl.	Shipments Bbl.	Stocks at End of Month Bbl.
January.....	4,098,000	2,539,000	10,300,000
February.....	4,379,000	3,331,000	11,400,000
March.....	6,763,000	6,221,000	12,000,000
April.....	8,651,000	7,919,000	12,600,000
May.....	9,281,000	9,488,000	12,450,000
June.....	9,296,000	10,577,000	11,150,000
July.....	9,568,000	10,301,000	10,414,000
August.....	10,244,000	12,340,000	8,280,000
September.....	10,027,000	11,329,000	6,953,000
October.....	10,506,000	12,114,000	5,348,000
November.....	8,921,000	5,195,000	9,091,000
	91,734,000	91,354,000	.....

Forest Products Laboratory Requires Increased Appropriation

For more than 10 years the Forest Products Laboratory at Madison, Wis., has been studying wood, always with the object of developing its most efficient and economical use. During that period it has amassed a great deal of scientific information of the most practicable application. Considerable credit is conceded the laboratory for its research accomplishments, but in the final analysis the value of its work must be measured by the extent to which the results of its work are made known and effectively applied by the wood-manufacturing industries. It is believed that this phase of the work is not being developed to an extent which its research results and industrial needs justify.

It is well recognized that those in charge have been endeavoring to remedy this situation, as evidenced by the information disseminated currently through trade and technical publications, by direct distribution of technical notes, by instructional courses in box construction and kiln drying, and in the facilities offered for direct co-operation in applying its information to specific manufacturing problems. In order to develop its dissemination work even to this extent, it has been necessary in certain cases to require co-operators to bear the cost of dissemination. This of necessity limits the broad usefulness of the laboratory and tends to restrict its information and services to the relatively few individuals and companies which are conversant with its work and the value of its results.

This is a situation which ought not to exist. It is one easily remedied, and the remedy lies in a specific appropriation by Congress for the dissemination and application of the results commensurate with its research activities and accomplishments.

The application of research is largely a matter of education, and when research is conducted as a governmental activity, adequate facilities must be provided for carrying the results through to their commercial application. This seems so thoroughly established as to forego argument. In its agricultural research and development the Department

of Agriculture has solved the problem in a highly satisfactory and profitable way by placing county agents in every state in the Union, whose duties are to advise and educate the farmers in better methods of farming.

There is at Madison a great deal of information which it has never been possible to supply to the industries, because the finances are not available to put this information in usable shape for the business man. There should be an adequate force to prepare all data of practical application in a form which the business man can readily grasp and apply. In addition, men are needed whose whole time may be devoted to field work. The duties of these men should be to carry the information, now available and being made use of by the relatively few, to the men in the sawmill, or in the lumber yard, or in the wood-using plant. Personal contact is an effective means of disseminating practical, scientific information.

As concrete examples of some of the ways by which the dissemination of this knowledge should be developed, the following may be mentioned: expansion of instructional work in kiln drying, box construction, and special co-operative tests under a plan by which the expense is at least shared equally by the government and the co-operator; the assignment of field representatives to disseminate results in such fields as the preservation of mine timbers, the kiln drying of lumber, the proper working values of wood in building codes, the protection of wood pulp and pulpwood from decay in storage; and the demonstration of improved processes on a commercial scale, such as the cooking and bleaching of Southern pine for magazine and book paper, increasing the yield of methanol in destructive distillation, the utilization of sawdust and mill waste for cattle feed, and the de-inking of old magazines and newspapers.

The current annual appropriation for forest products research amounts to \$325,000. This is equivalent to less than 25c. for every \$1,000 of raw manufactured value for the total annual cut of wood. On the other hand, the Department of Agriculture is spending for agricultural research and development \$1.50 for every \$1,000 of value of all agricultural and animal products.

The service above outlined requires a \$100,000 increase in the appropriation. The Secretary of Agriculture and the director of the budget have approved \$340,000 for the research work of the laboratory for the fiscal year beginning July 1, 1922. These estimates will be presented to Congress. They are contained in the estimates for the Forest Service, U. S. Department of Agriculture, and will be considered first by the sub-committee on agriculture of the House Committee on Appropriations and later by the Senate Committee on Agriculture. Sidney Anderson of Minnesota is chairman of the House sub-committee.

Slight Decrease in Unemployment in New York

The New York Committee on Unemployment Statistics reports that on Dec. 15 there were 331,000 unemployed persons in that city. This is about 13 per cent of number of persons reported by the federal census to have been gainfully employed on Jan. 1, 1920. On Oct. 17 the committee had reported 343,000 persons out of work, or 13.5 per cent of the total with gainful occupation.

The number of persons so employed in New York City on Oct. 17 and Dec. 15, as classified by groups, follows:

Group:	With Gainful Occupation January, 1920		Approximate Unemployment as of			
	Number	Per Cent	Oct. 17, 1921	Per Cent	Dec. 15, 1921	Per Cent
Manufacturing and mechanical industries.....	951,889	37.6	143,071	15	173,840	18
Clerical occupations and trades.....	793,966	31.4	72,996	9	39,309	5
Domestic and personal service.....	306,069	12.1	26,940	9	23,900	8
Transportation.....	242,447	9.6	63,000	26	58,900	24
Professional service.....	168,375	6.7	26,940	16	24,774	15
Public service.....	61,084	2.4	9,163	15	9,163	15
All other occupations.....	7,919	3	1,029	13	1,029	13
	2,531,747	100	342,860	13.5	330,915	13

The greatest increase in unemployment has occurred in the building trades, which include about 125,000 workers, listed under "manufacturing and mechanical industries." This has resulted from seasonal conditions.

Contractor Interested in Muscle Shoals

C. C. Tinker, president of the Construction Company of North America, the contracting concern constructing the Hetch Hetchy tunnel in California, has an appointment with the Secretary of War on Jan. 5 to discuss Muscle Shoals. While considerable publicity has been given to the statement that Mr. Tinker has hopes of submitting a more attractive offer than that of Henry Ford, the details of his plan have not been announced. It is stated that the government is to be relied upon for at least a portion of the financing.

To Discuss Fertilizer Matters in Conference at Department of Agriculture

Research and educational problems in the fertilizer industry are to be discussed on Jan. 6 at a conference at the Department of Agriculture. At that time the soil improvement committee of the National Fertilizer Association will meet with the department's officials who are interested in fertilizers for a general discussion of the present situation. It is the first meeting of the kind with the federal department, although the soil improvement committee has arranged similar conferences on several occasions at state agricultural colleges and at state experiment stations.

British Industries Fair to Be Held in London and Birmingham

Since its inception in 1915 the British Industries Fair has grown until it is today the most important national trade fair in the world. For the 1922 fair, to be held Feb. 27 to March 19, it has been possible to obtain enough additional accommodation both in London and Birmingham not only to provide for the annual growth of the fair but also to find room for the great industries which have hitherto exhibited at Glasgow. Textiles will, however, not be included in the 1922 fair.

The function of this fair, which is organized by the Department of Overseas Trade, is to bring buyer and seller together and to facilitate business between them by every legitimate means. Participation is confined to manufacturers and admittance is restricted to trade buyers, so that business is not impeded by crowds of sightseers.

The London section of the fair will, as in 1921, be housed in the White City, an enormous range of exposition buildings within a few minutes of the center of London, while the Birmingham section will again be in the great buildings of the Castle Bromwich Aerodrome, within easy reach of the center of the city. Further information can be obtained from the Trade Department of the British Consulate-General at New York.

Imports of Chemicals Decrease in November, but Exports Increase Slightly

Further decreases in the imports of chemicals were registered in November, it is shown by the figures just compiled by the Bureau of Foreign and Domestic Commerce. The decrease applies to chemicals on the free list as well as those on the dutiable list. The aggregate value of the free-list chemicals imported during November was \$3,983,567. This compares with \$4,342,505 in October and \$10,914,341 in November of 1920. The value of the dutiable chemicals imported in November is given as \$2,085,144. This compares with \$2,785,348 in October, and \$4,639,186 in November of 1920.

The value of all chemicals exported in November was \$4,938,494. This is a slight increase over October, when the value of exports totaled \$4,671,310. It is a great decrease, however, from November, 1920, when exports totaled \$12,894,772. A comparison of some of the items which make up these totals is as follows:

	Nov., 1920	Nov., 1921
Dyes and dyestuffs.....	\$2,310,751	\$500,918
Acids.....	506,379	76,744
Extracts for tanning.....	165,389	99,445
Total sodas.....	1,961,519	708,364

The imports of coal-tar products dropped from \$2,107,682 in November, 1920, to \$509,550, in November of this year. The value of the gums imported in November of this year was \$1,756,868. This compares with \$3,252,296 in November of 1920. That a part of this decrease is represented by shrinkage of value is shown by the fact that there was 7,294,528 lb. of the various gums imported in November of this year, whereas 9,228,269 lb. was valued at the much higher figure in 1920. An indication of the trend of color imports may be had from the following table:

	Nov., 1920	Nov., 1921
Germany, lb.....	353,099	47,758
Switzerland, lb.....	109,421	131,872
United Kingdom, lb.....	44,705	15,384
Other countries, lb.....	55,411	4,473

Personal

WILLIAM J. BURGESS, formerly associated with the National Aniline & Chemical Co. in its production of resorcinol, has assumed the duties of chemical supervisor of the resorcinol plant of the Pennsylvania Coal Products Co., at Petrolia, Pa.

ROBERT E. DEVINE, formerly with the Joslin Smith Co., Cincinnati, Ohio, and more recently doing independent consulting work, has become associated with the Armour Soap Works in Chicago, where he is carrying on special investigation work on plant processes.

Dr. H. L. FISHER, chemical director of the B. F. Goodrich Co., Akron, Ohio, addressed the members of the Delaware Section of the American Chemical Society, Dec. 21, on "Rubber Chemistry."

F. G. JACKSON has been added to the chemical staff at the Bureau of Mines ceramic station at Columbus, Ohio. Mr. Jackson has been working as a physical chemist at the submarine base at New London, Conn.

Dr. FRANK E. E. GERMAN, of the University of Colorado, read an instructive paper on Nov. 28 on "Thermal Analysis as a Method of Discovering New Compounds" before the Colorado Section of the American Chemical Society. Dr. German spoke particularly of the hydroxides of uranium.

Prof. R. G. GUSTAVSON, of the University of Denver, read a paper Dec. 13 before the Teknik Club of Denver on "Colloids."

ERNEST LERICHE, formerly with the Newport Chemical Co. at Milwaukee, has become associated with Schaar & Co., Chicago.

JAMES H. POST has been elected president of the Cuban-American Sugar Co., New York, N. Y., succeeding Robert B. Rawley, deceased.

A. E. SCHAAR, of Schaar & Co., Chicago, will sail for Holland Jan. 4. He expects to visit the principal cities of Europe.

R. B. STRINGFIELD, who has been chemical engineer for the Los Angeles plant of the Goodyear Tire & Rubber Co., has been transferred to the parent plant at Akron, Ohio, in connection with chemical engineering development there.

A. P. VANGELDER announces that in January he will retire from the active ranks of the organization of the Hercules Powder Co., where he has been general superintendent.

Obituary

JOHN C. PENNIE, senior member of the firm of Pennie, Davis, Marvin & Edmonds, patent attorneys, died in New York City on Dec. 23, 1921. A more extended notice will appear in a subsequent issue of this magazine.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

What We Hope to Accomplish in Our Market Pages

Reference has already been made in the editorial columns of this issue to the magazine's plans for extending the scope of its usefulness and thus increasing the service it is able to render to its readers. It is believed that one of the ways in which this purpose can be served is through the market pages, since they represent already established contact with commercial factors in the chemical and allied industries. By broadening the conception of these pages to include the discussion of market conditions and of those economic and business problems that have important bearing on trade and commerce in chemicals, it is hoped to present information of value to the chemical engineer and technical executive as well as to the man engaged in the actual buying and selling of chemical products.

The weekly price quotations which have become one of the features of CHEM. & MET.'s service to the industries are to be continued, and no effort will be spared in making them accurate, trustworthy indexes of business in the chemical and allied industrial markets. The market letters from New York and other centers of trade and commerce are to be written from this broader viewpoint in order to reflect national as well as local conditions in these markets. From time to time these columns will contain brief reviews of business, commerce and finance and of the relation to the chemical industry of such important factors as the tariff, taxation, foreign exchange and international trade. It is hoped that space can be given occasionally to pertinent industrial notes and reports from individual firms whose activities influence or have a marked effect upon conditions in the chemical market. In a word, then, it is our intention to make these pages a source of interesting and reliable commercial information, and to this end it is hoped that we may have the co-operation of all who are interested in advancing the best interests of the chemical, metallurgical and related industries.

Some High Spots in Business During 1921

The outstanding characteristic of business during the year just past has been the reaction toward certain economic tendencies and developments. Prominent among these has been the world-wide process of deflation and the gradual return to a mythical state of normalcy. Although the process has not yet been completed and further readjustment appears to be inevitable, the chemical industry has at least kept pace with the general trend of liquidation. Price indexes of the government and other agencies place chemicals on a level only slightly higher than the average for all commodities. Indeed, many basic chemicals are being offered at prices which are less than pre-war costs.

Falling prices, both in this country and abroad, have had a demoralizing effect on business. International trade has been seriously affected by this element of uncertainty, although it is believed that in some cases the apparent decreases may have been caused by lower unit costs. This point is well illustrated by a comparison of our present export trade with that of the pre-war period and of 1920. A quantity survey recently completed by the U. S. Chamber of Commerce shows that "of the twenty exports that are of the greatest tonnage, fifteen registered increases in poundage ranging from 43 to 5,210 per cent for the first 9 months of 1921, as compared with the 9 months average for the pre-war period, 1910 to 1913. Losses on the five other

commodities were from 5 to 32 per cent." Furthermore, over half of these commodities have been exported in larger tonnages during 1921 than during the corresponding period of the preceding year.

An equally important factor in shaping the year's business has been the fluctuations in foreign exchange. In a subsequent issue it is our intention to present a detailed study of the trend of the principal currencies of the world, but for the purpose of the present review it is perhaps sufficient to direct attention to two outstanding examples. The German mark, which 6 months ago was worth 1.5c., fell to 0.35c. during November. On the other hand, there is the phenomenal recovery of the pound sterling from \$3.53 in January, 1921, to \$4.24 early in December.

POLITICAL DEVELOPMENTS—TAXATION AND THE TARIFF

Political developments of the year have been disappointing on the whole, although in a few instances they appear to have taken a somewhat favorable turn. The Disarmament Conference may not accomplish all that might be desired, but it must be admitted that it has effected savings which will ultimately benefit industry. The new revenue law has also been the source of some disappointment. Instead of offering a new and constructive solution for our tax problems, the old war revenue act has been patched up and overhauled for additional service. Some consolation, however, is gathered from the repeal of the excess profits tax which is effective Jan. 1, 1922, in the reduction of the levy on capital gains and in the repeal of the transportation and other of the so-called "nuisance" taxes.

The tariff, although figuring prominently in the political developments of the year, can scarcely be said have had a beneficial influence on industry. In fact the year witnessed a rather general change in the attitude of many manufacturers toward the tariff. There appeared to be a growing feeling that the time was inappropriate for tariff framing and that little practical assistance could be obtained from such legislation. The inorganic chemical industry has had to meet a great deal of foreign competition, which in a number of instances has proved disastrous to the domestic producers. The dye and organic chemical industries, on the other hand, have been less affected, largely because of the continued control of imports provided by the dye and chemical section of the emergency tariff act.

The important lesson taught by the year, however, has been to emphasize the absolute necessity for increasing plant efficiencies and thus lower production costs. The period of retrenchment and careful, competent management must continue despite the few signs of encouragement that are gradually making their appearance. Inventories, both of raw materials and finished products, must be reduced, costs brought down and every preparation made for a severe, competitive fight for business. It is in this direction that future advance must be made. Economies of production, rather than expanded volume, promise greatest profits for business during 1922.

Growing Demand for Zinc Compounds

The increased production of rubber tires, with corresponding greater consumption of zinc oxide, has resulted in a growing demand for chemical derivatives of zinc. At the present time about 50 per cent of the zinc production is being used by the chemical trades, while the other 50 per cent is divided among the brass, galvanizing, sheet zinc and affiliated industries. This compares with averages of 25 and 75 per cent, respectively, in former years.

A Review of the Chemical Market During 1921

During the closing months of 1920 there was a widely prevalent feeling that the chemical and allied industrial markets would show evidence of marked improvement during the first 3 months of 1921. Unfortunately this revival was not effected. Liquidation continued throughout the entire year and business reversals were more common in the chemical industry than ever before. Our newly developed export trade in chemicals practically disappeared during the early part of the year as foreign exchange sank to depths at which competition was impossible. Only recently, however, Japan and certain South American countries have turned their attention to the American market and have placed orders for large tonnages of phenol and various other general chemicals. During the later months of 1921 Italy has also been a frequent buyer and domestic manufacturers of caustic soda have reported business to this country in as large as 1,000-ton lots.

COMPARATIVE PRICES OF 45 IMPORTANT CHEMICALS,
JANUARY, 1921-JANUARY, 1922

Article	Unit	Jan., 1921	April	June	Oct.	Jan., 1922
Acetic acid, glacial.....	Lb.	\$0.10	\$0.09	\$0.09	\$0.10	\$0.10
Muriatic acid, 20 deg.....	Lb.	.01	.01	.01	.01	.01
Nitric acid, 40 deg.....	Lb.	.07	.06	.06	.06	.06
Oxalic acid.....	Lb.	.18	.17	.18	.13	.14
Sulphuric acid, 66 deg.....	Ton	21.00	19.00	18.00	17.00	17.00
Acetate of lead.....	Lb.	.13	.11	.11	.10	.10
Ammonia alum, lump.....	Lb.	.04	.04	.03	.03	.03
Aluminum sulphate, iron free	Lb.	.03	.03	.03	.02	.02
Salammoniac, white, gran.....	Lb.	.10	.06	.06	.06	.07
Ammonium sulphate.....	Lb.	.03	.02	.02	.02	.02
Amyl acetate.....	Gal.	4.50	4.00	4.00	3.25	2.40
Arsenic, white, powder.....	Lb.	.11	.07	.06	.05	.06
Barium chloride.....	Ton	75.00	60.00	59.00	47.00	52.00
Bleaching powder.....	100 lb.	3.25	2.55	2.15	2.50	2.50
Calcium acetate.....	100 lb.	2.00	1.75	2.00	2.00	1.75
Camphor.....	Lb.	.90	.63	.75	.80	.91
Copperas.....	100 lb.	1.50	.75	.85	.80	.75
Copper sulphate, crystals.....	100 lb.	6.50	5.50	5.75	5.00	5.65
Epsom salt, U.S.P.....	100 lb.	3.00	2.75	2.40	2.50	2.65
Formaldehyde, 40 per cent.....	Lb.	.18	.14	.13	.11	.10
Fusel oil, refined.....	Gal.	3.50	3.25	3.00	3.00	2.50
Glauber's salt.....	100 lb.	1.75	1.50	1.50	1.50	1.30
Glycerine, sp.....	Lb.	.20	.16	.16	.14	.16
Methanol, 95 per cent.....	Gal.	1.50	.75	.78	.66	.62
Nickel salt, single.....	Lb.	.13	.14	.15	.14	.14
Phosphorus, red.....	Lb.	.40	.45	.45	.40	.45
Potassium bichromate.....	Lb.	.17	.12	.11	.10	.10
Potassium bromide, gran.....	Lb.	.35	.20	.16	.14	.15
Carbonate of potash, 80-85 per cent.....	Lb.	.11	.06	.05	.04	.04
Chlorate of potash, crystals.....	Lb.	.12	.08	.08	.08	.06
Caustic potash, 88-92 per cent.....	Lb.	.14	.07	.05	.05	.05
Pernanganate of potash, U.S.P.....	Lb.	.60	.35	.31	.18	.16
Prussiate of potash, yellow.....	Lb.	.33	.26	.24	.20	.23
Salt cake, bulk.....	Ton	45.00	33.00	30.00	20.00	18.00
Soda ash, light.....	100 lb.	1.85	2.10	2.15	2.05	1.80
Bichromate of soda.....	Lb.	.09	.07	.08	.07	.07
Fluoride of soda.....	Lb.	.17	.12	.11	.10	.11
Cyanide of soda.....	Lb.	.23	.19	.19	.25	.27
Caustic soda, solid.....	100 lb.	3.75	3.65	4.15	4.05	3.75
Nitrate of soda.....	100 lb.	2.50	2.60	2.90	2.35	2.30
Prussiate of soda.....	Lb.	.17	.11	.12	.14	.16
Sulphide of soda, 60 per cent	Lb.	.06	.05	.05	.04	.04
Sulphur, crude.....	Ton	16.00	20.00	20.00	18.00	18.00
Zinc chloride, gran.....	Lb.	.12	.11	.11	.09	.09
Zinc oxide, XX.....	Lb.	.10	.08	.09	.07	.07

The import business for the first 6 months of 1921 progressed exceptionally in the face of many adverse conditions. German interests, aided by the low mark, shipped goods into the American market at prices lower than domestic costs. The latter part of the year has been different to some extent. Imports of chemicals have shrunk noticeably. In October, 1921, the value of arrivals was \$7,127,853, as compared with the corresponding month of 1920, which was \$19,192,039. This represented a drop of over 60 per cent. The value of September, 1921, imports was much less—\$6,506,192. The past year showed some rather striking advances in imports and as many exceptional decreases. Naphthalene and coal-tar intermediates dropped over 60 per cent. Fusel oil, crude camphor and potassium cyanide lost over 70 per cent. Carbonate of potash fell from 16,313 tons to 2,898 tons; sodium nitrate from 581 to 174 long tons. Miscellaneous coal-tar crudes dropped over 90 per cent.

Some of the advances were equally marked. Calcium salts advanced over 10 per cent; sodium cyanide, 25 per cent, miscellaneous potassium salts, 60 per cent. Caustic potash rose from 778 to 3,908 tons, bleaching powder from

495 to 4,581 tons, benzene from 104 to 820 tons. To counterbalance the last two items, we exported 6,408 tons of bleach and 32,280 tons of benzene.

In general, the American chemical industry has undoubtedly just passed its most trying crisis. The industry has been severely dealt with and the new year will put it to a further test. Although there were many setbacks during the 12 months of depression, the results have not been disastrous. The encouraging feature of our industry is that everybody in the trade is hopeful and optimistic. The future is not without hope and everyone in trade circles is determined to fight hard to overcome the business depression that has proved so disastrous to some of the domestic producers.

Mathieson Alkali Works Reports Encouraging Business Conditions

E. M. Allen, president of the Mathieson Alkali Works, in a letter to the stockholders states that while general business is still unstable, that of the company shows material improvement during the last 3 months and appears to justify a hopeful outlook for the future. The output of the Niagara plant has gradually been increased until it is now approximately 80 per cent of capacity. During the recent inactivity, arrangements were made to increase materially the output of certain profitable products to replace others whose manufacture and sale have proved less profitable. The Saltville works of the company are operating at only about half capacity, but, as pointed out in Mr. Allen's letter, "because of improved physical and management conditions, the production substantially equals the average output of the entire plant during the past 9 years."

Regarding trade conditions in the alkali industry, Mr. Allen points out that "although competition has been unusually keen and average selling prices have gradually decreased, the company's position is believed to be fairly secure because of many new contracts made for 1922 delivery and a considerable tonnage which will be carried over under 1921 contracts, and it is believed that lower cost of production will keep pace with decreased selling prices."

The New York Market

NEW YORK, Dec. 30, 1921.

There were but few developments in the chemical market during the past week, owing to the holidays and the slow season of the year. However, those close to the heart of industry believe that the latter part of January will see a marked revival in the general list, with prices more stabilized. An important announcement by the domestic manufacturers of *sodium cyanide* that a reduction of 4c. per lb. would become effective Jan. 1 came as a considerable surprise to the trade, since foreign material has been held firm by a majority of the resale trade.

Another outstanding feature of the industry is the continued rise of *yellow prussiate of soda*. Some believe the advance of foreign exchange has had a strengthening influence on this commodity, while others contend that the natural working of the law of supply and demand has made prices firm. Prices opened at 16c. per lb. and closed with the majority of dealers asking up to 17½c. per lb. Still another item that commanded attention was *caustic potash*, 88-92 per cent, on which spot prices advanced noticeably, even though large tonnages of imported material have already been docked. These lots, in most cases, had been previously consigned to various domestic consumers. The present market ranges from 6@6½c. per lb., ex-store New York. Solid *caustic soda* has not attracted new consumers, and business in this commodity will be dull until the latter part of January. Leading producers report a large part of their output already sold on contract over 1922 at \$2.75 per 100 lb., f.o.b. works, basis 60 per cent. Spot prices range from \$3.80@4 per 100 lb., f.o.b. or f.a.s. New York. Small-lot trading has featured the market on *bichromate of soda* and sales were made at 7½c. per lb. In some quarters it was intimated that round-lot business would shade prices down to 7½c. per lb. Demand has not been active, but supplies in resale quarters are not abundant and prices seem

to be well in line with manufacturing costs. *Yellow prussiate of potash* advanced in sympathy with prussiate of soda. Although the demand cannot be termed active, spot supplies are rather scarce and prices are quoted firmer at 24@25c. per lb., according to quantity. The red prussiate has also been advanced, and prices range from 30@30½c. per lb. *Light soda ash* has been in moderate demand during the week and prices were slightly firmer. Imported material was quoted around \$1.80 per 100 lb., ex-dock. Domestic material in single bags ranged from \$2@2.10 per 100 lb.

The Chicago Market

CHICAGO, Dec. 30, 1921.

Trading in industrial chemicals during the past 2 weeks has been slow. No one expects a revival of even fair business until after the first of the year. With reference to prices there was little of real importance done over this period and most factors are holding to the idea that business could not have done during these last weeks of the year at any reasonable scale of prices. The only reports of shading came from weak holders and these offers failed to disturb the market to any great extent. All factors are generally optimistic over the prospects for next year and in some quarters are preparing for a considerable increase in both inquiries and actual business.

The alkali market is very quiet at the present and prices are slightly easier. *Caustic soda* was offered today at \$4 per 100 lb. for the solid 76 per cent and the ground at \$4.65@4.70 in ton lots. There is little material moving, as deliveries on 1922 contracts will soon start and then low prices are predicted for the coming year. *Caustic potash* is quiet and unchanged at 6½c. per lb. for the 88-92 per cent material. Soda ash lacks quotable change in first hands and is moving only in small parcels at \$2.60 per 100 lb. basis cooerage.

Supplies of *potash alum* are rather light and 6c. per lb. for the lump and 6½c. for the powdered were the best offers noted. *Aluminum sulphate* is quiet at \$3.25 per 100 lb. for the iron free. *White arsenic* was reported to be moving in a fair way at 6½@7c. per lb. *Bleach* is quiet at 3@3½c. per lb. for large drums. Another advance on *glycerine* was announced by refiners, which brings the c.p. material to 16c. per lb. drum basis. This item is one of the very few which is apparently enjoying a good demand. Single *nickel salts* is also in good demand and the price is firm at 12@13c. per lb.

Potassium bichromate is still slow, with supplies plentiful at 13@13½c. per lb. *Bichromate of soda* has assumed a firmer position and it was impossible to do better than 9½c. for material of standard brand. *Chlorate of potash* is scarce on spot and 8½@9c. were the prevailing quotations for the powdered. Spot stocks of the crystals could not be located and 10c. was the best offer on material for shipment from the East. The *prussiates of potash* are both firm and scarce. The red crystals are held for 30c. per lb. in small lots and the yellow at 25c. *Salammoniac* is firm with supplies none too plentiful. Holders are asking 8@8½c. for the white granular in large casks and are said to be doing a fair volume of business. The condition of the acid market remains unchanged and may be characterized as very dull.

The Iron and Steel Market

PITTSBURGH, Dec. 30, 1921.

The year now ending has been the smallest for steel production since 1905, production of steel ingots being not over about 20,000,000 gross tons, so that the industry had, in a sense, a setback of 16 years, which is a new record. The setback in point of tonnage was also a new record, about 55 per cent from the record tonnage, made in 1917, 43,619,200 tons.

The year 1921 opened with steel ingot production at the rate of about 30,000,000 tons, although a rate of about 42,000,000 tons had been maintained during the first 9 months of 1920, before the tapering off began. Production decreased almost continuously until at the middle of July the rate was barely over 10,000,000 tons a year. Then improvement began, carrying the rate up to about 25,000,000

tons at the beginning of November. To the end of the year there was some falling off, but the rate even now, despite holiday dullness, is probably above 20,000,000 tons, and a return to a rate of 25,000,000 tons within a few weeks, or 2 months at the outside, is far from improbable.

STEEL CONSUMPTION

Almost invariably when the steel appears scarce and prices are high it is remarked in the trade that there are no stocks of consequence and that liquidation will therefore be easy, but in every instance the event has proved that the stocks existed. Even 1920, with an apparent scarcity indicated by the fanciest prices in the whole history of the industry, has proved no exception. At the beginning of 1921 there were stocks of steel in the hands of buyers, both jobbers and manufacturing consumers, and there were stocks of manufactured wares, including agricultural implements, machinery, hardware, tools, etc., in the hands of manufacturers and distributors. All these stocks had to be liquidated, and it was chiefly the process of liquidation that caused steel production to fall to its extremely low level in July. An incident was that in the early months of the year customers of the United States Steel Corporation took larger tonnages of steel than they currently needed.

PRICES DURING 1921

The last day of 1920 had seen the disappearance of the last extra price on the part of independents. All independents had advanced prices above the Steel Corporation level in 1920, the corporation alone adhering to the Industrial Board schedule, promulgated March 21, 1919. Late in the year independent prices began to drop to the corporation level, pipe being the last. During January there was a steady market. Early in February independents got on the other side from the one they occupied in 1920, and began cutting the Steel Corporation's prices. In April the corporation reduced and from that time on there was only one market, quite an irregular one. On the whole the Steel Corporation, on account of the good will acquired by its price policy in 1920, was able to obtain slightly higher prices, on an average, than the independents, but the difference was only a dollar or two a ton, while in 1920 the difference the other way was frequently \$10 or \$20.

Two-thirds of the total decline in steel prices in 1921 occurred in the 6 months from Feb. 1 to Aug. 1, when the market experienced a succession of falls. Afterward there was only a gentle sagging now and then, with attempts, rarely successful, at recovery. A weighted average of all the important finished steel products showed 3.25c. at the beginning of the year and 2.16c. at the end, a decline of about \$22 per net ton, or just one-third, and putting prices at a level 26 per cent above the average of 1913 and 52 per cent above the low level of December 31, 1914.

THE MARKET FOR THE WEEK

The steel market has been extremely quiet in the past week, reflecting the usual holiday or pre-inventory dullness. The quietness has given no concern to producers or buyers, being regarded as altogether natural. The market really lost most of its snap about the middle of October, the remarkable thing being that production held up so well notwithstanding the dullness of the market.

As noted in our last report the Steel Corporation reduced its prices on wire products \$5 a ton, this following a reduction a week earlier in tubular goods, each reduction having been made on account of price cutting by independents. In the past week nothing has occurred as to steel prices, which are fairly steady. The liquidation has been quite thorough and no further changes of any consequence are to be expected for some time to come. The next change worth mentioning may come by buyers being ready to make purchases for forward deliveries, in which case some slight extra concessions may be brought out.

Four contracts for Connellsville furnace coke for the first quarter of the new year have been made, at prices ranging from \$3.25 to \$3.50, the variation being probably due chiefly to quality. The spot market is very soft, with \$3 scarcely even an asking price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 - \$0.45
Acetone.....lb.	\$0.12 - \$0.12	.13 - .13
Acid, acetic, 28 per cent.....100 lbs.	2.75 - 3.00	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99 per cent, carboys.....100 lbs.	10.00 - 10.50	10.75 - 11.00
Boric, crystals.....lb.	.12 - .12	.13 - .13
Boric, powder.....lb.	.13 - .13	.14 - .14
Citric.....lb.	—	.44 - .46
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.12 - .12	.13 - .13
Lactic, 44 per cent tech.....lb.	.09 - .10	.10 - .12
Lactic, 22 per cent tech.....lb.	.04 - .04	.04 - .05
Molybdic, a.p.....lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.06 - .06	.06 - .07
Nitric, 42 deg.....lb.	.06 - .07	.07 - .07
Oxalic, crys. salt.....lb.	.14 - .15	.15 - .16
Phosphoric, 50 per cent solution.....lb.	.13 - .13	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.	—	1.65 - 1.75
Sulphuric, 60 deg., tank cars.....ton	—	11.00 - 12.00
Sulphuric, 60 deg., drum.....ton	—	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	—
Sulphuric, 66 deg., drum.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	—	.75 - .85
Tannic (tech.).....lb.	.55 - .60	.61 - .65
Tartaric, imported crystals.....lb.	—	.26 - .27
Tartaric acid, imported, powdered.....lb.	—	.27 - .28
Tartaric acid, domestic.....lb.	—	.31 - .32
Tungstic per lb. of WO.....lb.	—	1.10 - 1.20
Alcohol, ethyl.....gal.	—	4.65 - 5.00
Alcohol, methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.42 - .43
Alcohol, denatured, 190 proof.....gal.	—	.43 - .44
Alum, ammonia, lump.....lb.	.03 - .03	.04 - .04
Alum, potash, lump.....lb.	.03 - .04	.04 - .04
Alum, chrome lump.....lb.	.08 - .08	.08 - .09
Aluminum sulphate, commercial.....lb.	.01 - .02	.02 - .02
Aluminum sulphate, iron free.....lb.	.02 - .02	.03 - .03
Aqua ammonia, 26 deg. drums (750 lb.) lb.	.07 - .07	.08 - .08
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	.30 - .30	.31 - .33
Ammonium carbonate, powder.....lb.	.07 - .07	.08 - .09
Ammonium chloride, granular (white sal ammoniac).....lb.	.07 - .07	.07 - .07
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07 - .07	.07 - .07
Ammonium nitrate.....lb.	.07 - .07	.07 - .08
Amylacetate tech.....gal.	—	2.40 - 2.50
Arsenic oxide, (white arsenic) powdered lb.	.06 - .06	.06 - .07
Arsenic, sulphide, powdered (red arsenic) lb.	.12 - .12	.12 - .13
Barium chloride.....ton	52.00 - 53.00	54.00 - 55.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.06 - .07	.07 - .08
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .04	.04 - .05
Blanc fixe, dry.....lb.	.04 - .04	—
Blanc fixe, pulp.....ton	45.00 - 55.00	—
Bleaching powder (see calc. hypochlorite).....ton	—	—
Blue vitriol (see copper sulphate).....ton	—	—
Borax (see sodium borate).....ton	—	—
Brimstone (see sulphur, roll).....ton	—	—
Bromine.....lb.	.23 - .24	.25 - .28
Calcium acetate.....100 lbs.	1.75 - 2.00	—
Calcium carbide.....lb.	.04 - .04	.05 - .05
Calcium chloride, fused, lump.....ton	23.00 - 24.00	24.50 - 28.00
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02
Calcium hypochlorite (bleach powder) 100 lb.	2.50 - 2.60	2.65 - 3.25
Calcium peroxide.....lb.	—	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.90 - .95
Carbon bisulphide.....lb.	.06 - .06	.07 - .07
Carbon tetrachloride, drums.....lb.	.10 - .10	.11 - .12
Carbonyl chloride, (phosgene).....lb.	—	.60 - .75
Caustic potash (see potassium hydroxide).....ton	—	—
Caustic soda (see sodium hydroxide).....ton	—	—
Chalk, precip.—domestic, light.....lb.	.04 - .04	—
Chalk, precip.—domestic, heavy.....lb.	.03 - .04	—
Chalk, precip.—imported, light.....lb.	.04 - .05	—
Chlorine, gas, liquid-cylinders (100 lb.) lb.	.08 - .09	.09 - .10
Chloroform.....lb.	—	.38 - .40
Cobalt oxide.....lb.	—	2.00 - 2.10
Copperas (see iron sulphate).....ton	—	—
Copper carbonate, green precipitate.....lb.	.20 - .20	.21 - .21
Copper cyanide.....lb.	—	.50 - .62
Copper sulphate, crystals.....100 lb.	5.65 - 5.70	5.75 - 6.25
Cream of tartar (see potassium bitartrate).....ton	—	—
Epsom salt (see magnesium sulphate).....ton	—	—
Ethyl acetate com. 85%.....gal.	—	.70 - .80
Ethyl acetate, pure (acetic ether, 98% to 100%).....gal.	—	.95 - .95
Formaldehyde, 40 per cent.....lb.	.10 - .11	.11 - .12
Fuller earth, f.o.b. mines.....net ton	16.00 - 17.00	—
Fuller earth—imported powdered—net ton	22.00 - 24.00	—
Fusel oil, ref.....gal.	—	2.50 - 3.00
Fusel oil, crude.....gal.	—	1.50 - 1.75
Glauber's salt (see sodium sulphate).....ton	—	—
Glycerine, a. p. drums extra.....lb.	—	.16 - .16
Iodine, resublimed.....lb.	—	3.80 - 3.90
Iron oxide, red.....lb.	—	.12 - .18
Iron sulphate (copperas).....ton	15.00 - 16.00	17.00 - 20.00
Lead acetate.....lb.	—	.10 - .12
Lead arsenate, powd.....lb.	.15 - .15	.15 - .16
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.08 - .08	.08 - .09
Magnesium carbonate, technical.....lb.	.07 - .07	.08 - .09
Magnesium sulphate, U. S. P.....100 lb.	2.65 - 2.70	2.75 - 3.00
Magnesium sulphate, technical.....100 lb.	—	1.10 - 1.75
Methanol, 95%.....gal.	—	.62 - .63

	Carlots	Less Carlots
Methanol, 97%.....gal.	\$... - \$...	\$0.64 - \$0.65
Nickel salt, double.....lb.	—	.12 - .12
Nickel salt, single.....lb.	—	.14 - .14
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.	—	.32 - .35
Potassium bichromate.....lb.	.10 - .11	.11 - .11
Potassium bitartrate (cream of tartar).....lb.	—	.25 - .27
Potassium bromide, granular.....lb.	—	.15 - .20
Potassium carbonate, U. S. P.....lb.	.15 - .16	.17 - .20
Potassium carbonate, 80-85%.....lb.	.04 - .04	.05 - .06
Potassium chlorate, crystals.....lb.	.06 - .06	.06 - .12
Potassium cyanide.....lb.	—	.43 - .45
Potassium hydroxide (caustic potash).....lb.	.06 - .06	.06 - .06
Potassium iodide.....lb.	—	2.90 - 3.00
Potassium nitrate.....lb.	.07 - .07	.08 - .09
Potassium permanganate.....lb.	.15 - .16	.16 - .22
Potassium prussiate, red.....lb.	.30 - .30	.31 - .31
Potassium prussiate, yellow.....lb.	.24 - .24	.25 - .25
Rochelle salts (see sodium potas tartrate).....ton	—	—
Sal ammoniac (see ammonium chloride).....ton	—	—
Sal soda (see sodium carbonate).....ton	—	—
Salt cake (bulk).....ton	—	18.00 - 21.00
Soda ash, light.....100 lb.	1.80 - 2.10	2.15 - 2.50
Soda ash, dense.....100 lb.	2.15 - 2.20	2.25 - 2.50
Sodium acetate.....lb.	.04 - .04	.04 - .05
Sodium bicarbonate.....100 lb.	2.30 - 2.35	2.40 - 2.75
Sodium bichromate.....lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake).....ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P.....lb.	.04 - .05	.05 - .06
Sodium borate (borax).....lb.	.05 - .06	.06 - .07
Sodium carbonate (sal soda).....100 lb.	1.80 - 1.90	1.95 - 2.15
Sodium chloride.....lb.	.06 - .07	.07 - .08
Sodium chloride.....long ton	12.00 - 13.00	—
Sodium cyanide.....lb.	.26 - .26	.26 - .27
Sodium fluoride.....lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda).....100 lb.	3.75 - 3.80	3.85 - 4.25
Sodium hypsulphite.....lb.	—	.03 - .03
Sodium nitrite.....lb.	.06 - .06	.07 - .07
Sodium peroxide, powdered.....lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic.....lb.	.04 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts) lb.	—	.19 - .21
Sodium prussiate, yellow.....lb.	.17 - .17	.17 - .18
Sodium silicate, solution (40 deg.).....100 lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (60 deg.).....100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.30 - 1.50	1.60 - 2.00
Sodium sulphide, fused, 60-62 per cent (cone.) lb.	.04 - .04	.04 - .05
Sodium sulphite, crystals.....lb.	.03 - .03	.04 - .04
Sodium sulphite, powdered.....lb.	.10 - .11	.11 - .15
Sulphur chloride, red.....lb.	.05 - .06	.06 - .06
Sulphur, crude.....ton	18.00 - 20.00	—
Sulphur dioxide, liquid, cylinders extra.....lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour.....100 lb.	—	2.25 - 3.10
Sulphur, roll (brimstone).....100 lb.	—	2.00 - 2.75
Talc—imported.....ton	30.00 - 40.00	—
Talc—domestic powdered.....ton	18.00 - 25.00	—
Tin bichloride.....lb.	.09 - .09	.09 - .10
Tin oxide.....lb.	—	.39 - .40
Zinc carbonate.....lb.	.14 - .14	.15 - .16
Zinc chloride, gran.....lb.	.09 - .09	.09 - .10
Zinc cyanide.....lb.	.42 - .44	.45 - .47
Zinc dust.....lb.	.11 - .11	.11 - .12
Zinc oxide, XX.....lb.	.07 - .07	.08 - .09
Zinc sulphate.....100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....lb.	1.25 - 1.30
Alpha-naphthylamine.....lb.	.30 - .32
Aniline oil, drums extra.....lb.	.17 - .19
Aniline salts.....lb.	.24 - .26
Anthracene, 80% in drums (100 lb.).....lb.	.75 - 1.00
Benzaldehyde U.S.P.....lb.	1.35 - 1.45
Benzidine, base.....lb.	.90 - 1.00
Benzidine sulphate.....lb.	.75 - .85
Benzoic acid, U.S.P.....lb.	.60 - .65
Benzoate of soda, U.S.P.....lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.).....gal.	.27 - .32
Benzene, 90%, in drums (100 gal.).....gal.	.25 - .28
Benzyl chloride, 95-97%, refined.....lb.	.25 - .27
Benzyl chloride, tech.....lb.	.20 - .23
Beta-naphthol benzoate.....lb.	3.75 - 4.00
Beta-naphthol, sublimed.....lb.	.70 - .75
Beta-naphthol, tech.....lb.	.30 - .34
Beta-naphthylamine, sublimed.....lb.	1.65 - 1.75
Cresol, U. S. P., in drums (100 lb.).....lb.	.15 - .16
Ortho-cresol, in drums (100 lb.).....lb.	.24 - .26
Cresylic acid, 97-99%, straw color, in drums.....gal.	.70 - .80
Cresylic acid, 75-97%, dark, in drums.....gal.	.65 - .70
Cresylic acid, 50%, first quality, drums.....gal.	.45 - .50
Dichlorobenzene.....lb.	.06 - .09
Diethylaniline.....lb.	.95 - 1.10
Dimethylaniline.....lb.	.40 - .45
Dinitrobenzene.....lb.	.23 - .27
Dinitrochlorobenzene.....lb.	.20 - .25
Dinitronaphthalene.....lb.	.30 - .35
Dinitrophenol.....lb.	.35 - .40
Dinitrotoluene.....lb.	.25 - .30
Dip oil, 25%, car lots, in drums.....gal.	.30 - .35
Diphenylamine.....lb.	.60 - .70
H-acid.....lb.	1.00 - 1.10
Meta-phenylenediamine.....lb.	1.10 - 1.15
Monochlorobenzene.....lb.	.12 - .14
Monoethylaniline.....lb.	1.65 - 1.70
Naphthalene crushed, in bbls.....lb.	.07 - .08
Naphthalene, flake.....lb.	.07 - .08
Naphthalene, ball.....lb.	.08 - .09
Naphthionine acid, crude.....lb.	.70 - .75
Nitrobenzene.....lb.	.12 - .15
Nitro-naphthalene.....lb.	.30 - .35
Nitro-toluene.....lb.	.15 - .17
Ortho-amidophenol.....lb.	3.00 - 3.10
Ortho-dichlorobenzene.....lb.	.15 - .20
Ortho-nitro-phenol.....lb.	.77 - .80
Ortho-nitro-toluene.....lb.	.15 - .20

Ortho-toluidine.....	lb.	.20	—	.25
Para-amidophenol, base.....	lb.	1.40	—	1.45
Para-amidophenol, HCl.....	lb.	1.70	—	1.80
Para-dichlorobenzene.....	lb.	.12	—	.15
Paranitroaniline.....	lb.	.77	—	.80
Para-nitrotoluene.....	lb.	.80	—	.85
Para-phenylenediamine.....	lb.	1.70	—	1.75
Para-toluidine.....	lb.	1.25	—	1.40
Phthalic anhydride.....	lb.	.37	—	.40
Phenol, U. S. P., drums.....	lb.	.11	—	.15
Pyridine.....	gal.	2.00	—	3.50
Resorcinol, technical.....	lb.	1.50	—	1.60
Resorcinol, pure.....	lb.	2.00	—	2.25
Salicylic acid, tech., in bbls.....	lb.	.20	—	.21
Salicylic acid, U. S. P.....	lb.	.22	—	.23
Salol.....	lb.	.70	—	.72
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25	—	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14	—	.16
Sulphanilic acid, crude.....	lb.	.27	—	.30
Toluidine.....	lb.	1.30	—	1.35
Toluidine, mixed.....	lb.	.43	—	.45
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.28	—	.31
Xylidines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, pure, in tank cars.....	gal.	.45	—	.....
Xylene, commercial, in drums, 100 gal.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	.....

Waxes

Prices are quotably unchanged for the entire list.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.30	—	5.35
Rosin E-I.....	280 lb.	5.40	—	5.50
Rosin K-N.....	280 lb.	6.05	—	6.75
Rosin W. G.-W. W.....	280 lb.	7.00	—	7.25
Wood rosin, bbl.....	280 lb.	6.25	—	.....
Spirits of turpentine.....	gal.	.81	—	.....
Wood turpentine, steam dist.....	gal.	.79	—	.....
Wood turpentine, dest. dist.....	gal.	.78	—	.....
Pine tar pitch, bbl.....	200 lb.	.....	—	6.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	.....	—	9.50
Retort tar, bbl.....	500 lb.	.....	—	9.50
Rosin oil, first run.....	gal.	.36	—	.....
Rosin oil, second run.....	gal.	.39	—	.....
Rosin oil, third run.....	gal.	.46	—	.....
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	.....	—	\$1.90
Pine oil, pure, dest. dist.....	gal.	1.50	—	.....
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46	—	.....
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.....	—	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—	.....
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	.....	—	.35
Turpentine, crude, sp.gr. 0.900-0.970.....	gal.	1.25	—	.....
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.35	—	.....
Pine wood creosote, ref.....	gal.	.52	—	.....

Fertilizers

Ammonium sulphate, bulk and double bags.....	100 lb.	\$2.30	—	2.90
Blood, dried, f.o.b., N. Y.....	unit	4.00	—	.....
Bone, 3 and 50, ground, raw.....	ton	30.00	—	32.00
Fish scrap, dom., dried, f.o.b. works.....	unit	2.90	—	3.00
Nitrate soda.....	100 lb.	2.30	—	2.35
Tankage, high grade, f.o.b. Chicago.....	unit	2.75	—	3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%.....	ton	4.50	—	6.50
Tennessee, 78-80%.....	ton	8.50	—	9.00
Potassium muriate, 80%.....	ton	34.00	—	35.00
Potassium sulphate.....	unit	.90	—	1.00

Crude Rubber

Quotations have remained unchanged since our previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.10	—	\$0.10
Castor oil, AA, in bbls.....	lb.	.11	—	.12
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.13	—	.13
Coconut oil, Ceylon grade, in bbls.....	lb.	.09	—	.09
Coconut oil, Cochin grade, in bbls.....	lb.	.10	—	.10
Corn oil, crude, in bbls.....	lb.	.08	—	.08
Cottonseed oil, crude (f. o. b. mill).....	lb.	.07	—	.07
Cottonseed oil, summer yellow.....	lb.	.08	—	.09
Cottonseed oil, winter yellow.....	lb.	.09	—	.09
Linseed oil, raw, car lots (domestic).....	gal.	.67	—	.68
Linseed oil, raw, tank cars (domestic).....	gal.	.62	—	.63
Linseed oil, in 2-bbl lots (domestic).....	gal.	.70	—	.71
Olive oil, denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08
Peanut oil, refined, in bbls.....	lb.	.11	—	.11
Rapeseed oil, refined in bbls.....	gal.	.82	—	.83
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.90
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.43	—	.....
Yellow bleached menhaden.....	gal.	.44	—	.....
White bleached menhaden.....	gal.	.46	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

Prices remain unchanged throughout the list.

Refractories

All prices remain the same as figures appearing in our Dec. 28 issue.

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrocobalt, per lb. of Cr contained, 6-8% carbon, carlots.....	lb.	.12	—	.....
Ferrocobalt, per lb. of Cr contained, 4-6% carbon, carlots.....	lb.	.13	—	.....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport.....	gross ton	54.00	—	58.35
Spiegel, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	.....
Ferrosilicon, 16-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	25.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaport.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.24	—	.25
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04	—	.13

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....	Cents per Lb.	13.875
Aluminum, 98 to 99 per cent.....	.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	.....	4.50
Nickel, ordinary (ingot).....	.....	41.00
Nickel, electrolytic.....	.....	44.00
Monel metal, shot and blocks.....	.....	35.00
Monel metal, ingots.....	.....	38.00
Monel metal, sheet bars.....	.....	40.00
Tin, 5-ton lots, Straits.....	.....	33.125
Lead, New York, spot.....	.....	4.70
Lead, E. St. Louis, spot.....	.....	4.375
Zinc, spot, New York.....	.....	5.25@5.30
Zinc, spot, E. St. Louis.....	.....	4.80@4.85

OTHER METALS

Silver (commercial).....	oz.	\$0.65
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	80.00-84.00
Iridium.....	oz.	150.00@170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	49.00-50.00

FINISHED METAL PRODUCTS AND OLD METALS

Quotations have remained unchanged since our previous report.

Structural Material

The following base prices per 100 lb. of structural shapes 3 in. by 3 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named

	New York	Cleveland	Chicago
Structural shapes.....	\$2.78	\$2.88	\$2.78
Soft steel bars.....	2.68	2.78	2.68
Soft steel bar shapes.....	2.68	2.78	2.68
Soft steel bands.....	3.28	3.48	3.28
Plates, 1/2 to 1 in. thick.....	2.78	2.88	2.78

*Add 15¢ per 100 lb. for trucking to Jersey City and 10¢ for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORT SMITH—The Page Milling & Smelting Co. has leased property in Benton County, totaling over 500 acres of copper land, and plans for the construction of a new refining plant on a portion of the site. The initial installation will comprise a 150-ton concentrating plant and auxiliary buildings.

California

ANAHEIM—The Anaheim Sugar Co. is considering preliminary plans for the erection of a new mill, estimated to cost about \$250,000, including machinery. D. Jessurun is president.

SAN FRANCISCO—The Pacific Sanitary Mfg. Co., 67 North Montgomery St., manufacturer of sanitary earthenware, is planning for extensions in its plant at Richmond, Cal., to cost about \$60,000.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. is perfecting plans for the immediate erection of the first building at its new local plant at South Wilmington, to be followed by the construction of seven other plant buildings. The entire plant is estimated to cost close to \$1,000,000.

Florida

ARCHER—The Maddox Foundry & Machine Co. is considering tentative plans for the erection of a 40 x 50-ft. addition to its foundry. H. Maddox is general manager.

Illinois

CHICAGO—The Oxweld Acetylene Co. has purchased the property it has been occupying under lease, at Jasper Place, near 37th St. The plant was acquired at an indicated \$173,500.

Indiana

BLOOMINGTON—The Bloomington Brick & Tile Co., with headquarters at Indianapolis, is considering plans for the erection of a new brick, tile and other burned clay products manufacturing plant at Bloomington, estimated to cost about \$200,000, including machinery. Work will be commenced in the spring. A. W. Beecher is president.

INDIANAPOLIS—The Piel Bros. Starch Co., 331 State Life Bldg., has awarded a contract to Latham & Walters, State Life Bldg., for a 1-story top addition at its plant, 200 x 200 ft., with improvements in the present factory, estimated to cost about \$50,000. William F. Piel is president.

Iowa

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., has preliminary plans in preparation for the erection of a new cement-manufacturing plant at Dubuque, estimated to cost about \$1,500,000 for initial mills. The building contract has been awarded without competition to H. C. Stuchen, Dakota Bldg., St. Paul, Minn. The C. L. Pillsbury Co., 1200 Second Ave., South Minneapolis, Minn., is engineer.

Louisiana

BATON ROUGE—The Standard Oil Co. of Louisiana is planning to increase the capacity of its local refinery, including extensive storage facilities, comprising about 20 tanks, each with capacity of 55,000 bbl. The company is said to have purchased the plant of the Export Oil Corp., at Avondale, La., for a consideration of about \$950,000, and will continue the operation of the refinery. Fire recently damaged a portion of the company's distributing plant on South Claiborne Ave., New Orleans, with loss reported at about \$30,000.

Maryland

BALTIMORE—The United States Industrial Alcohol Co., Curtis Bay, has tentative plans under consideration for the erection of a new 1-story plant in the Stonehouse Cove section, 50 x 180 ft. It is said that work will be started in the spring.

Massachusetts

SPRINGFIELD—Fire recently destroyed a portion of the plant of the Fiberloid Co. No official estimate of loss has been made.

BOSTON—The Eastern Metal & Refining Co., 121 Beverly St., has taken out a permit to rebuild the portion of its foundry recently damaged by fire.

Michigan

KALAMAZOO—The Sanitary Mfg. Co., manufacturer of sanitary earthenware products, will build a new addition to its plant, 112 x 400 ft., estimated to cost about \$200,000, including equipment. It is expected to have the extension ready for occupancy in the late spring, adding about 125 men to the working force for operation.

DETROIT—The Solvay Process Co. has completed plans for the erection of a 1-story addition to its local building, 22 x 50 ft., estimated to cost about \$15,000. Maurice H. Finkel, 333 Majestic Bldg., is architect.

New Jersey

LINDEN—The Warner-Quinlan Co., 79 Wall St., New York, has plans under way for the erection of the second section of its new oil refinery and asphalt plant at Linden, estimated to cost about \$1,000,000. The entire plant will cost about double this amount and will replace a works recently destroyed by fire. The Gifford, Huntze, Baker Engineering Corp., 40 Rector St., is engineer. Bids will be asked at an early date.

BELLEVILLE—Fire, Dec. 16, destroyed a portion of the plant of the Federal Leather Co., River Road, with loss reported at about \$12,000.

JERSEY CITY—Colgate & Co., 105 Hudson St., manufacturers of soaps, etc., have construction under way on a new 3-story plant addition, 100 x 125 ft., with cost estimated at about \$140,000. The Turner Construction Co., 244 Madison Ave., New York, has the erection contract.

New York

NEW YORK—The Goodyear Tire & Rubber Co., 123 West 64th St., with plant at Akron, O., is concluding negotiations with the Brazilian Government for permanent rights on certain state property, heretofore held under limited concessions, with site to be used for the erection of a large rubber-manufacturing plant. The project has been planned a number of years ago, but has been held in abeyance owing to industrial conditions.

Oklahoma

PONCA CITY—The Chamber of Commerce is perfecting plans for the establishment of a local brick-manufacturing plant. A new company will be formed, it is said, to construct and operate the property.

HENRYETTA—The Henryetta Glass Mfg. Co. has acquired local buildings and plant site for the establishment of a new factory for the manufacture of glass specialties. Machinery will be installed and operations commenced at an early date.

TULSA—The Oklahoma Tanning & Mfg. Co. has acquired the plant heretofore occupied by the Pawpaw Refining Co., for the establishment of a new tannery. Machinery and equipment will be installed to provide for a daily output of about 250 tanned hides.

GRANITE—The Town Council is considering preliminary plans for the erection of a new municipal gas plant and distributing system. A bond issue will be arranged to cover the cost of the improvement.

Pennsylvania

POTTSTOWN—The Vulcurel Rubber Co. has acquired property, 300 x 392 ft., on West High St., to be used as a site for the erection of a new 2-story plant for the manufacture of automobile tires and other rubber products. It will be 60 x 260 ft., supplemented with a 1-story building for general operations and storage service.

PHILADELPHIA—Horace T. Potts & Co., 316-20 North Third St., manufacturers of iron and steel castings and other metal products, are perfecting details for the erection of their proposed new foundry

buildings at Erie Ave. and D St., and will break ground for the structures early in the spring. The new plant is estimated to cost in excess of \$150,000. The William Steele & Sons Co., 1600 Arch St., is the contractor. H. T. Potts is head.

PHILADELPHIA—The Pennsylvania Sugar Co., North Delaware Ave., has acquired additional property in the vicinity of its local refinery, 83 x 146 ft., adjoining other land lately acquired, to be used for proposed future expansion. The last purchase was acquired for a consideration of about \$18,000.

CHESWICK—The Stonecrete Corp., 6023 Penn. Ave., has commenced the erection of its proposed new plant at Cheswick, to be equipped for the manufacture of cement products. Charles B. Lawton heads the company.

Tennessee

CHATTANOOGA—The Crane Enamelware Co., occupying the former plant of the Mutual Enamelware Co., is arranging for a state charter with capitalization of \$2,000,000, for the manufacture of enamelware products of all kinds. Increased production will be arranged in the line of sanitary ware, supplementing the present output of plumbing fixtures, etc. The company is headed by Hugh W. Powell and Frank H. Caldwell.

CHATTANOOGA—The Southern Cotton & Paper Co. has been organized by Mercer Reynolds and associates, Chattanooga, with capital of \$200,000, for the erection of a new plant at Nashville, Tenn. A site has been acquired at that place and construction will be commenced at an early date. The plant will specialize in the manufacture of bond and kraft papers from cotton linters.

MEMPHIS—The Memphis Varnish Co., owned by the De Soto Paint Co., has let contract for the erection of a 2-story building to be used for a varnish plant at East Railroad Ave. and South Somerville St. The plant and the equipment represent an initial investment of about \$50,000. New storage tanks will be installed to take care of between 250,000 and 300,000 gal. of liquid.

Texas

WORTHAM—The Wortham Refining Co., recently organized, has perfected plans for the immediate erection of a new oil-refining plant in the northern section of the borough. It is proposed to have the refinery ready for operation in from 60 to 90 days, with initial output of about 400 bbl. per day. The plant will be of one-unit type, and will be increased at a later date. H. G. Lemendes is president; and Roger Seeley, secretary and treasurer.

SANTA ANA—The Industrial Department of the Santa Fe Railway Co. is developing plans for the establishment of a local plant for the manufacture of glass products. The project will be carried out in conjunction with a new company to be organized, headed by F. E. Brazelton, Santa Ana.

EL PASO—The American Smelting & Refining Co., 120 Broadway, New York, is considering the erection of a large metallurgical experimental plant on local site for testing ores from its properties at Monterey, Mex.

MINERVA—The Owens Refining Co., First National Bank Bldg., Cameron, Tex., will construct its proposed new oil refinery in this section on a site acquired at Minerva. It will have an initial daily output of about 1,200 bbl. W. A. Jones is construction engineer for the company. John S. Owens is president and manager.

GAINESVILLE—The Lone Star Co. has commenced the erection of a new condensing plant with number of other buildings for a new works to produce gasoline from natural gas. It is planned to have the plant ready for operation early in 1922. It will cost about \$75,000.

AMARILLO—The Panhandle Brick & Tile Co. has commenced operations at its new local plant, and will develop production in the line both of brick and tile from clays secured in this section. The plant has a rated capacity of 100,000 bricks per day.

Virginia

GRAHAM—The Columbia Chemical Co., Roanoke, Va., is perfecting plans for extensions and improvements in its plant at Graham. Work will be commenced at an early date.

West Virginia

WHEELING—The Wheeling Mold Foundry Co. has construction under way on a 1-story addition to its plant, 60 x 285 ft., estimated to cost about \$50,000. It will be equipped as a roll shop.

Capital Increases, Etc.

THE WHITE TAR CO., 56 Vesey St., New York, N. Y., with plant at Kearny, N. J., has filed notice of increase in capital from \$100,000 to \$300,000.

THE HOOD RUBBER CO., East Watertown, Mass., has arranged for a note issue of \$6,000,000, to be used for general operations, financing, etc.

THE MONARCH CHEMICAL CO., Saginaw, Mich., has filed notice of dissolution under state laws.

THE HEAT UNIT TILE CO., 616 Fidelity Bldg., Tacoma, Wash., has filed notice of increase in capital from \$100,000 to \$300,000. Frederick H. Murray heads the company.

Upon petition by stockholders, a temporary receiver has been appointed for the NEW MEXICO FIREBRICK CO., Gallup, N. M.

THE W. S. VICK CHEMICAL CO., Knoxville, Tenn., has filed notice of change of name to the Gilbert Chemical Co., at the same time increasing its capital from \$100,000 to \$250,000.

THE DETROIT INDEPENDENT OIL CO., Detroit, Mich., has filed notice of increase in capital from \$25,000 to \$150,000.

THE AJAX RUBBER CO., Trenton, N. J., has arranged for a bond issue of \$3,000,000, the proceeds to be used for financing, general operations, etc.

C. BISCHOFF & CO., 451 Washington St., New York, N. Y., has filed notice of change of name to the Carbic Color & Chemical Co.

THE CONDENSED BLUING CO., 66 East South Water St., Chicago, Ill., has filed notice of increase in capital from \$50,000 to \$100,000.

THE STANDARD OIL CO. OF INDIANA, Indianapolis, has been granted permission by the Indiana Securities Commission to issue common stock for \$40,000,000.

New Companies

THE IMPERIAL REFINING CO., Lock Haven, Pa., has been incorporated with a capital of \$100,000, to manufacture refined oil products. S. H. Fredericks, Lock Haven, is treasurer.

ALBACH & STUEHLER, INC., Elizabeth, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are Carl H. Stuehler, Morris M. and Maxwell M. Albach, 210 Broad St., Elizabeth.

THE RIVERSIDE BRONZE & ALUMINUM CO., River and Lloyd Sts., New Haven, Conn., has been organized to manufacture bronze, brass, aluminum and other metal products. T. E. Hyde is president, and H. S. Brown, treasurer.

THE NORTHWESTERN RUBBER CO., Seattle, Wash., has been incorporated with a capital of \$100,000, to manufacture rubber products of various kinds. The company is headed by C. E. Elliott, and is represented by Van Dyke & Thompson, 812 Lowman Bldg., Seattle.

THE SHULBERG CO., INC., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture paper products. The incorporators are L. and S. Shulberg, and I. Gettinger. The company is represented by Gettinger & Weiman, 63 Park Row, New York.

THE POLY CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$70,000, to manufacture chemicals and chemical byproducts. The incorporators are F. Haber, L. Rothstein and V. Blancher. The company is represented by Charles Firestone, 299 Broadway, New York.

THE STANDARD FOUNDRY PRODUCTS CO., 661 East Lafayette St., Detroit, Mich., has been incorporated with a capital of \$15,000, to manufacture iron and other metal castings. The incorporators are Karl D. Stellwagen, Anthony J. Detlaff and Joseph F. Racine, 647 East Lafayette St., Detroit.

THE LYNCHBURG PAINT & COLOR CORP., Lynchburg, Va., has been incorporated with a capital of \$25,000, to manufacture paints, varnish, colors, etc. A. T. Quick, Jr., is president, and H. B. Hughes, secretary, both of Lynchburg.

THE RICH STEEL PRODUCTS CO., Vernon, Cal., has been incorporated with a capital of \$3,500,000, to manufacture iron and steel products. The incorporators are Richard L. North, L. L. Otis, H. F. Prince and S. M. Haskins. The company is represented by Gibson, Dunn & Crutcher, 1111 Merchants' National Bank Bldg., Los Angeles, Cal.

THE REX MCDILL CO., Haines City, Fla., has been incorporated with a capital of \$200,000, to manufacture chemicals and chemical byproducts. Rex D. McDill is president and general manager, and Fred J. Hampton, secretary, both of Tampa, Fla.

THE BAINSTVILLE OIL & REFINING CO., Wilmington, Del., has been incorporated under state laws with a capital of \$5,100,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Wilmington.

THE PENN LEATHER PRESERVING CO., Pittsburgh, Pa., has been incorporated with a capital of \$10,000, to manufacture leather preservatives and kindred compounds. N. B. Trumbo, McKees Rocks, Pa., is treasurer.

THE CURTIS PROCESS REFINING CO., Indianapolis, Ind., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are F. A. Curtis, C. B. Cox and B. W. Templeton, all of Indianapolis.

THE GOLD SEAL CO., Bloomfield, N. J., has been incorporated with a capital of \$125,000, to manufacture fiber products and affiliated specialties. The incorporators are George M. Browning, Robert W. Nicholls and William P. Baerenrodt, 251 Spruce St., Bloomfield.

THE KLEAN-O PRODUCTS CORP., 1307 North Clark St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture chemical compounds and preparations. The incorporators are N. M. Strebel, H. W. Bjernson and Sexton Bruce.

THE AMBER OIL CO., Bowling Green, Ky., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are J. E. Waldron, A. H. Malaney and B. J. White, all of Bowling Green.

THE WATER VALLEY FOUNDRY CO., Buffalo, N. Y., has been incorporated with a capital of \$20,000, to manufacture iron and other metal castings. The incorporators are M. A. and C. A. Fries, and J. L. Babinger. The company is represented by Harding & Harding, attorneys, Buffalo.

THE UNICO POTTERY CO., Trenton, N. J., has been incorporated with a capital of \$125,000, to manufacture sanitary earthenware and other pottery products. The incorporators are John Morgan, William G. Amiason, Sr. and Jr., 77 Frazier St., Trenton.

THE CLINCH RIVER ZINC CO., Memphis, Tenn., has been incorporated with a capital of \$500,000, to operate zinc properties and manufacture zinc products. The incorporators are John Cunningham, Arlington, Tenn.; and P. R. Cary and B. D. Bird, both of Memphis.

THE BRITE-LITE POLISH CO., Tulsa, Okla., has been incorporated with a capital of \$25,000, to manufacture polishes and kindred products. The incorporators are P. G. Heffelfinger and S. S. Bassett, both of Tulsa.

THE SEARCHLIGHT PAINT SUPPLY CO., 5-7 Commerce St., Baltimore, Md., has been incorporated with a capital of \$25,000, to manufacture paints, oils, etc. The incorporators are William H. and Charles I. Jamieson, and Bernard J. Flynn.

BRUCKNER, LIPPMAN & JACOBS, INC., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture leather products. The incorporators are M. Bruckner, I. Lippman and D. S. Jacobs. The company is represented by Joseph Kohler, 280 Broadway, New York.

THE AMERICAN CONCRETE TILE & PRODUCTS CO., 426 New Amsterdam Bldg., Baltimore, Md., has been incorporated with a capital of \$250,000, to manufacture cement roofing tile and kindred products. The incorporators are John W. Ritter, John E. Springer and John T. Davis.

THE WINDSOR LOCKS PAPER MILLS CO., Windsor Locks, Conn., recently incorporated, has been organized with H. H. Turner as president; H. E. Platt, Jr., treasurer; and J. R. Kedley, secretary, Windsor Locks, to manufacture paper products.

THE RUBBER PROCESS CORP., Detroit, Mich., has been incorporated with a capital of \$50,000, to manufacture rubber products under a special process. The incorporators are A. Frank Bigger, Leo and Eugene Siegel, 1060 Fort St., W., Detroit.

THE OXAGINE CHEMICAL MFG. CO., Wilmington, Del., has been incorporated under state laws with a capital of \$1,000,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Service Co., Wilmington.

THE ARISTO PRODUCTS CO., New York, N. Y., has been incorporated with a capital of 10,000, to manufacture polishes and kindred compound products. The incorporators are I. L. Hopkins, P. Berman and M. A. Karp. The company is represented by Goldstein & Phillips, 217 Broadway, New York.

THE ELIBI PRODUCTS CO., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are W. H. Haack, J. C. Williams and R. S. Kristeller. The company is represented by Watson, Kristeller & Swift, 63 William St., New York.

Manufacturers' Catalogs

THE HAMILTON COPPER & BRASS WORKS, Hamilton, O., has issued Bulletin 52 describing and illustrating Hamilton copper steam-jacketed kettles for the chemical and related industries. These kettles are furnished with or without agitators; one model is particularly designed for thick or lumpy materials. Capacities 25 to 250 gal. are carried in stock.

THE SULLIVAN MACHINERY CO., Chicago, Ill., has issued three new illustrated bulletins. Bull. 71-F is on the Sullivan Displacement Pump for Elevating Acid by Compressed Air; Bull. 70-W, on Sullivan Rotators and Bull. 71-G on the Sullivan Air Lift Pumping System, giving methods and apparatus.

THE CHICAGO PNEUMATIC TOOL CO., New York, has issued a special bulletin which should be of value to users of pneumatic tools, because it gives specifications which can be used as a reference when ordering tools. Bull. 70, on vacuum pumps, which is the first of its kind to be issued by this company, contains information on dry vacuum pumps, steam, belt or motor driven.

THE CHAPMAN ENGINEERING CO., Mt. Vernon, O., has issued a booklet on Erecting and Operating Instructions. It contains detailed instructions for successfully operating a bituminous gas producer.

TUN HAUSER-STANDER TANK CO., Cincinnati, O., announces a new publication entitled "Wooden Tanks for Every Purpose." The construction of wooden tanks for general use is shown, as well as specially constructed and irregular shaped tanks for special purposes. Especial attention is called to a study of the action of various chemicals upon different woods used for chemical tanks.

THE MINE SAFETY APPLIANCES CO., Pittsburgh, Pa., calls attention to Bulletin 72, on Burrell Gas Masks, for use in carbon monoxide and for all service.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 542 Broad St., Newark, N. J., the second Monday of every month.

PERKIN MEDAL will be presented to William M. Burton by the Society of Chemical Industry at its meeting Jan. 13 at the Chemists' Club, New York.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.